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GM-38 Area Groundwater Remedy Analysis Report

Naval Weapons Industrial Reserve Plant (NWIRP)

Bethpage, New York

Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

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TETRA TECH NUS, INC.

Response to Foster Wheeler Comments Dated January 16, 2003 on the December 2002 Draft Report for GM-38 Area Groundwater.

General Comments (GC)

GC-1 **Comment:** The Design Report bases all extraction rates, re-injection rates, and capture zones on a revised groundwater model prepared by Arcadis/G&M. The model is a regional model, which has been used for similar projects in the Bethpage area. TtNUS does not have information regarding site conceptual design, model parameters, or an electronic copy of the model. Therefore, we cannot verify the accuracy or reliability of the model results. The original model should be reviewed in order to determine the rationale and assumptions used in constructing the model. The required information includes the site conceptual model, input data, boundary conditions, and model grid layers. Arcadis/G&M have indicated that they will forward additional information to assist in our review.

Response: The extraction well locations and capture zone evaluations were based on the groundwater modeling efforts conducted by Arcadis G&M. Although details of the model were not checked by TtNUS, the general conclusions of the model output were independently checked by TtNUS. This check is based on past experience on and near the NWIRP Bethpage. Particular data used to support this information are summarized as follows.

Two pumping tests conducted in 1993 and provided in the Phase 2 RI Report (October 1993):

- A 448 gpm – 2.8 day pumping testing, followed by 3.8 days observation of recovery, well was screened to 135 feet below ground surface.

- An 890 gpm – 3 day pumping test, followed by a 3.8 days observation of recovery. Test used an existing Navy production well (No. 11) that was screened to 490 feet below ground surface.

Based on this data, a TtNUS computer model of the area was developed to evaluate particle flow paths and also in the Feasibility Study (March 1994) to evaluate the placement of near site groundwater capture wells. The model was calibrated under both steady state and transient conditions.

Model output included the following results.

- BWD well operation at Adam Street Plant (North Wells), with a combined pumping rate of approximately 2400 gpm in three developed a combined capture zone 3000 feet wide and 500 feet downgradient of the wells.

- Analysis of a near site groundwater extraction system included a line of wells on 675 foot centers, with each well pumping 400 gpm to provide complete capture of Site 1 water.

Independent calculations of the capture zone analyze were conducted by TtNUS. The calculations were run with conductivities of 25 feet per day, used by AGM, as well as 50 feet per day (common text book value for the area), and 100 feet per day as measured during the 1993 pump tests.

Based on this range of data, as well as uncertainty with the effective thickness of the aquifer, TtNUS' evaluation concludes that the AGM predicted capture zones are within a reasonable range of capture zones that may actually develop, without a bias. For example, the TtNUS' estimated capture zone width for recovery well RW-1 (at RW-1) ranges from 780 feet to 4,700 feet. The AGM predicted 10-year capture area width at this location is 1,900 feet. The TtNUS' estimated down gradient capture zone for RW-1 ranges from 250 feet to 1,500 feet. The AGM predicted 10-year down gradient reach at this location is 800 feet. A similar comparison applies for recovery well RW-2.

Overall, TtNUS concludes that the actual capture zones for the GM-38 recovery well system cannot be determined until a recovery and treatment system is in place and operating for a period of time. As such, during the analysis of the GM-38 Area system, TtNUS has evaluated each process unit to determine hydraulic limits. The general conclusion is that except for the pumps, the hydraulic limit of the system is approximately 2 to 3 times the anticipated rate of 1,100 gpm. The planned pumps should be able to increase throughput by approximately 50%, without additional modification.

At groundwater extraction rates that are higher than the anticipated rates, the capacity of the GM-38 Area system may become limited based on the contaminant loading. Since contaminant loadings equal the flow rate times the VOC concentration in the recovery wells; if excessive VOC concentrations occur, then the initial action will be to decrease the groundwater extraction rate accordingly. Overtime, the VOC concentrations in the recovery wells will decrease, and groundwater extraction rates can then be increased.

Similarly, if VOC concentrations in the recovery wells do not reach the anticipated concentrations, then the groundwater extraction rates can be increased to decrease the time of operation.

GC-2 __Comment:__ We would like to review any hydrogeologic data collected during the previous Remedial Investigation (RI) including boring logs, monitoring well water level data, groundwater elevation contour maps, aquifer testing results including pumping tests, slug tests, and re-injection tests. This data would be the basis of the groundwater numerical model, and the system design.

__Response:__ Available data will be provided.

GC-3 __Comment:__ The report includes calculations of contaminant mass. There is no narrative explaining the analytical method is how the volumes were determined.

__Response:__ The mass calculations are provided in Appendix A.

GC-4 __Comment:__ The report indicates that pumping will occur from two different depths and Figure 3-2 indicates that RW-1 will extract from the shallow groundwater zone and RW-2 will extract from the deeper zone. There are several clay layers between the two zones but there is mention that the deeper zone is confined and separate from the shallow zone. Groundwater elevations from the two zones would be helpful in confirming that the deep aquifer is confined.

Response: In 2001, a 1.5 foot downward gradient was noted between GM-38D2 and D, over a vertical difference of approximately 150 feet.

GC-5 **Comment:** TtNUS has not performed any aquifer testing because of the amount of water, which will be generated and treated during the pumping test. The aquifer test would likely require pumping rates of 1,000 gallon per minute. Even a short test would result in a significant amount of water that would have to stored and treated. We would recommend that aquifer testing be conducted after the treatment system has been constructed (i.e., during initial operation). However, there are risks associated with waiting until construction is complete in that a major design changes could have significant cost implications. The size of the building should take the possibility of design changes into account by allowing flexibility for space to add treatment components, if necessary.

Response: TtNUS concurs that capture zone analysis should be confirmed during system startup. A likely scenario would consist of a RW-2 test over several days, then a RW-1 test over several days, and finally a longer term evaluation of RW-1 and RW-2, in combination. This water would also allow the components of the treatment system to be evaluated at the same time.

Final analysis of system capture is expected to require weeks to years of operation. The building will be sized to accommodate reasonable future expansion requirements. If extension modifications are required in the future, then building add-ons can be considered.

GC-6 **Comment:** The current investigation has been conducted to determine the extent of the plume and some assumptions have been made using existing data from local water supply wells. There is likely a need for additional monitoring wells to delineate the groundwater contamination and to serve as observation wells during aquifer testing and system operation.

Response: TtNUS concurs. The remedy incorporates approximately 23 new and existing monitoring wells that would be used to evaluate capture zones. Please note that both capture zones and extent of contamination are estimated based on the available data. The system goal will actually be to capture contaminated groundwater meeting the definition of GM-38 Hotspot groundwater.

GC-7 **Comment:** There needs to be clarification with the New York State Department of Environmental Conservation (NYSDEC) regarding treatment objectives and goals. TtNUS indicated that groundwater contamination is pervasive throughout the area and this was evident by the number of air strippers found on local water supply wells. TtNUS's design is to recover and treat the plume (hot spot) of Total Volatile Organic Compounds (TVOC) above 500 ppb. This concentration is greater than the NYSDEC TAGM. If this value is not acceptable to the NYSDEC, significant design changes may be necessary, which could also impact the O&M period of performance.

Response: The goal of the GM-38 Area is for mass removal of VOCs from the aquifer. In the Feasibility Study that was developed in support of the ROD, a concentration of 1.0 mg/l is used to define the GM-38 Area. The ROD does not select an actual concentration to define boundaries of the area. However, as noted in the comment, to develop an target area, a concentration must be selected. The 0.5 mg/l value was presented to the TAC committee without adverse comment.

AGM has been using the 100 ug/l criteria in several of their presentations. However, based on TtNUS' review of the data, the 100 ug/l contour likely extends over 5000 feet wide and 8000 feet long in this area. The NYSDEC TAGM value encompasses an even larger area. Total plume containment was determined to be impractical to conduct.

GC-8 **Comment:** The proposed location of the injection wells is a small area and it would be prudent to conduct some testing to confirm that four usable injection wells can function in the limited space. Additionally, we recommend that the option of using the NYSDOT right-of-way along the Seaford Oyster Bay Expressway be explored for placement of wells.

Response: Based on theoretical calculations, only one well should be required to handle the anticipated flow rate of 1,100 gpm. However, because of maintenance, cleaning, and non-ideal conditions, the number of wells for the estimate was increased to 4. In practice, two wells should be installed initially. These wells can then be used to evaluate the effectiveness of injection wells. Additional wells should then only be installed if needed. If additional wells are required and the targeted area for injection wells is not adequate, then both the right-of-way for the Seaford Oyster Bay Expressway and the Town of Oyster Bay road should be considered.

GC-9 **Comment:** The GM-38 Area delineation (Section 2.2, page 2-2) presented two methods 1) maximum TVOC detected in each sample and 2) maximum average TVOC concentration within a computer layer in a boring. The maximum average TVOC concentration within in a computer layer is used in the modeling, quantity estimation and sizing of the treatment units. The maximum average TVOC concentration within in a computer layer is less conservative (least to say) in terms of areal extent of contamination and peak concentration to the treatment plant.

Typical treatment plant design will have factor of safety with regard to flow rate and/or influent concentration depending upon the confidence of the estimation. The design includes factor of safety with respect concentration by considering maximum concentrations in the design for stripper sizing (but not for liquid and vapor phase carbon units and miscellaneous equipment). The larger size liquid and vapor phase carbon units selected in the design will be sufficient to cover concentration slug. No factor of safety was included with respect to extraction flow rate in the design. In order to accommodate peak influent concentrations, higher flow rate and minor stripper media clogging, a larger capacity air blower with variable speed motor would be necessary.

Response: The system is sized to provide mass removal of VOCs in this area. As such, the system size and operation has flexibility that it not commonly found in these types of system, and in particular the system does not need to be sized to handle simultaneous peak flows and peak concentrations.

Peak VOC concentrations are most likely to occur near the beginning of the operation. However, based on some variability of contamination throughout the aquifer, total and individual chemical peak concentrations may occur at different times during the remediation.

Since the efficiency of the primary treatment unit (air stripping) increases with decreasing flow rate, if unexpectedly high VOC concentrations in the influent occur, they can be easily addressed with short-term decreases in the overall system flow rate. Later, when VOC concentrations decrease, extraction rates can be increased accordingly and eventually, to even higher rates than presented in the analysis report to accelerate the remediation.

GC-10 **Comment:** The current design has two recovery wells. Until model results can be reviewed it is difficult to assume that the two wells will be able to create an effective capture zone to treat the impacted area. If aquifer testing is going to be conducted after the construction of the treatment system, there is a possibility that the proposed extraction rates will be insufficient and higher extraction rates will be required to create an adequate capture zone. The system capacity and design should consider this possibility.

The hydrogeologic review was limited due to the lack of relevant site data included in the report. In order to conduct a thorough evaluation we would require the additional data from the remedial investigation and feasibility study tasks, as discussed above prior to completing the evaluation.

Any additional data related to the hydrogeology and the groundwater model would be helpful in completing the evaluation of the effectiveness of the groundwater extraction system. We understand that it would not be appropriate to conduct additional modeling for this system due to the extensive historical discussions with multiple parties. However, this data would assist Foster Wheeler Environmental in confirming that the design meets the intent of the Navy, and would allow us to provide for some flexibility for future adjustments to the system if the actual site conditions differ significantly from the parameters used in the Arcadis/G&M model.

Response: The additional data requested will be provided.

GC-11 Comment: While the Basis of Design does not address operational issues, we have some concerns about air emission monitoring during normal operations. The design makes some assumptions regarding allowable discharge levels, which could require significant sampling and/or continuous emission monitoring which is extremely expensive. A cost/benefit analysis should be performed to determine the benefit of designing the system for no detectable air emissions versus what may be allowed under state regulations.

Response: The concentration of VOCs in the effluent are based on NYS air discharge guidance. The calculated values are not assumptions.

Significant sampling or continuous emission monitoring is not anticipated. VOC breakthrough is generally slow and over the long term becomes predictable. Also, zero detectable emissions of VOCs can become very expensive to maintain, especially if detectable but insignificant concentrations of VC, DCA, DCE, or other VOCs are measured.

Specific Comments

1. **Comment:** Page 1-1. Page 1-2 is missing.

   Response: Page 1-2 was left blank to accommodate two-sided copying of the report.

2. **Comment:** Section 2.2, page 2-1 and Drawing C-1 Site Layout. Of the seven vertical profile borings, no borings were installed upstream and down stream (i.e., north and east) of GM-38 Area, where there is potential for higher concentration. There is not enough data to draw the 1000 ug/l or 500 ug/l (outer boundary) isoconcentration contour lines especially in north and east of the GM-38 Area. The proposed monitoring wells in Drawing C-1 should address this concern. However, it is recommended to include additional location east of Expressway in Chapin Road or Miller Road. Please note that extent of contamination will have direct impact on pumping rate and influent concentration ultimately the size of the treatment system and the remediation time frame.

Response: The extent of contamination in these other areas is reasonably well defined through well established groundwater flow patterns and groundwater quality results from upgradient monitoring wells and downgradient borings. Therefore we disagree with the comment regarding the adequacy of the data needed to draw the 500 ug/l and 1000 ug/l contours. Additional profile boring data (e.g. Chapin Road and Miller Road) is always good to have, but are not necessary. Instead, we are proposing to add permanent monitoring wells in this area to determine the presence/absence of contamination and capture by the GM-38 Area system.

VPB-42, which is located to the north and east of the GM-38 area, is relatively clean (maximum 21 ug/l VOCs), this boring was used to cut of the extent of contamination in this area. Approximately 1400 feet north of this area, another boring (VPB-49C) was installed. The maximum total VOC concentration detected in this boring was 57 ug/l. To the northwest of the Site are several monitoring wells that contain similar levels of VOCs.

TtNUS agrees that the extent of contamination will drive the necessary pumping rate, however, pumping rate, influent concentration, and size of the treatment system are inter-related and as discussed above can be readily addressed by normal variations in operation of the system.

3. **Comment:** Section 3.2, page 3-2; and Appendix A. Based on high sulfides and Chemical Oxygen Demand (COD) (Table 2-1 groundwater data) and low dissolved oxygen concentration (Appendix A, water sampling log), the groundwater is in reduced state. The groundwater compounds in reduced state will be oxidized that will form floc (solids) during the treatment. Considering air stripper operations in this area, only bag filtration before reinjection is provided to avoid/extend the duration of reinjection well fouling. However, additional confirmatory sampling and analysis is still recommended to confirm the extremely high COD in groundwater sample.

Response: TtNUS disagrees that based on this data, one can suggest that solids will form during the treatment process. Solids form primarily from the oxidation of iron and manganese from soluble reduced states to insoluble oxidized states. Iron and manganese were not identified in the groundwater at significant concentrations.

Sulfides at 4.0 m/l are not very high and will readily oxidize to sulfates, which are also very soluble. We agree that the high COD is difficult to explain and further testing should be considered.

TtNUS anticipates that test wells be installed first, followed by installation of the extraction wells. Once these wells are in, samples can be collected and limited field testing conducted to evaluate the potential formation of insoluble solids. This work can be conducted while the treatment system is being installed.

4. **Comment:** *Section 4.1.2, page 4-1. The existing air stripper tower inside should be inspected upon removal of the media, demister, etc. to determine the usability. During November 2002 site visit minor corrosion spots were noted outside skin of the air stripper tower.*

Response: TtNUS agrees that the air stripper tower should be inspected for structural integrity prior to being placed in service. It should be noted that the column is constructed with an aluminum shell and was only in operation for approximately 5 to 7 years.

5. **Comment:** Section 4.2.2, page 4-4. It is recommended to house the entire air stripper tower inside the building or properly insulate the feed pipe, air exhaust pipe, etc. that are exposed to elements.

Response: TtNUS expects that exterior piping would be evaluated during the detailed design to address freeze concerns. A constant and large supply of warm groundwater, as expected for this project would be expected to minimize these concerns.

The tower is approximately 40 feet high, and therefore it is not practical to house the entire unit within a building. This tower functioned outdoors for several years without any significant issues freeze issues. Based on the revised operation, TtNUS would expect the groundwater piping connections to the top of the tower to be heat traced and insulated and the vapor phase piping to be insulated.

6. **Comment:** Section 4.3, page 4-7. Please consider including services at the groundwater treatment building for office, storage, etc. No standby unit provided for any of the process unit except for bag filtration. Storage and working spaces are needed for spare parts, sampling equipment and supplies, clean filter bags, work bench/table, etc. Also include space for spent bag filters inside or outside of the treatment building. If outside storage/holding of spent bag filters (before disposal) is selected, then a security fence must be provided.

Since this is a relatively long-term operation conducted at a remote site, we feel that a full time operator may be necessary. We expect that potable water and sewage for restroom facilities will be required. It has been our experience that Federal Government facilities of this type may need to be handicapped-accessible.

Response: As discussed during our January 2003 meeting, the building size will be expanded to include a contingency system of liquid phase granular activated carbon, and an expanded vapor phase granular activated carbon system. The addition of these units have increased the building size by approximately 200%. TtNUS expects that only minimal storage space will be required within the facility.

Because insoluble solids handling is expected to be minimal after the initial operation, TtNUS does not expect that the full time operator will be required to operate this system beyond the first few months of operation. Operational staffing and the need to provide restrooms can be determined by the Navy.

7. **Comment:** Figures P-1, and P-2. Please check to see there is a need for a final blower before the exhaust stack. Also show building (i.e., indoor/outdoor) limits for clarity. The drawings and the text in Sections 4.0 and 5.0 should be consistent (e.g. packed air stripper vs. tray type air stripper, air blower (B-1) vs. air blower (AB-1), number of offgas GAC adsorption, etc.). Please add a note that control logic presented in these drawings are conceptual in nature the required control logic will be determined during detailed design.

Response: Before the requested addition of a second vapor phase GAC unit, the pressure drops through the system are not expected to be sufficiently high enough to require the use of a dual fan system. However, because of the second vapor phase GAC unit, a dual fan system will now be required.

The word tray is only used once in Section 4.0, and then only as part of a general description of the air stripping technology. The blower symbol B-1 versus AB-1 will be made consistent.

Foster Wheeler can modify the control logic during final design.

8. **Comment:** Appendix A. The model layer thickness calculation is not conservative as typically done in design. If no sample was collected for a particular depth, the next available sample results should be used. Conservative calculation will yield 70 feet, 123 feet, 50 feet for model layer 1000 ug/l, model layer 500 ug/l and individual sample – 500 ug/l, respectively.

   Response: The model layer thickness calculations presented in Appendix A are adequately conservative in nature for this analysis. The aquifer characteristics and in particular clay units, typically determine intervals in which samples were not collected and represent non-flow conditions. Therefore, these intervals do not represent data gaps, and do not add uncertainty to the calculations.

9. **Comment:** Appendix C, Standard Calculation Sheet, Section 2.1, page C-13. The screen depth for RW-1 and RW-2 indicated here is different from Figures 3-2 and 3-3 and Table 2 of Appendix D.

   Response: Appendix C will be revised to reflect the estimated screen interval for these wells. Arcadis had to revise the anticipated depth for RW-2 half-way through the evaluation.

10. **Comment:** Appendix C, Standard Calculation Sheet, pages 3 of 14 and 4 of 14, Section 3.1. The vapor flow rate should be corrected to 7,350 scfm.

Response: Agreed, a vapor flow rate of 7,350 cfm will be applied throughout the calculations. The vapor flow rate was revised part-way through the analysis to address verbal comments from Foster Wheeler.

Additional Items

Comment: In addition, the following issues/concerns were discussed during our January 9, 2003 meeting and agreed to consider in the design:

- Additional monitoring well downgradient of last Vinyl Chloride detection area to monitor Vinyl Chloride movement into extraction wells.
- Provision for high initial concentration in the extracted groundwater (e.g., additional vapor phase unit, additional air stripper capacity, etc.).
- Alternate/Backup discharge alternatives for treated groundwater (such as discharge to the existing storm water recharge basin or to the Publicly Owned Treatment Works).
- Liquid Phase Carbon Unit as a polishing treatment step.

Response:

- Two monitoring well clusters that are to be used to evaluate system capture are already planned for this area. The exact locations can be modified slightly to serve a dual purpose.

- As discussed above, there is adequate capacity and options to address potentially highly concentrations of VOCs in the influent water initially. An additional vapor phase carbon can be used initially to address uncertainties in the performance of the units until an operational history is developed.

- TtNUS agrees that alternative options for discharging the treated water should be pursued. POTW and basin discharge was addressed in the conceptual report and neither option was considered as viable as re-injection for long term operation. However, during startup and carbon change, relatively high concentrations of insoluble solids may be present in the system and may effect operation of the injection wells. Short term and contingency discharges of treated water to the POTW may be viable.

- As discussed during the meeting a liquid phase carbon unit will be added to the treatment train as a contingency measure. This contingency measure has added approximately $500,000 to the capital cost.

Response to Arcadis G&M Comments Dated January 8, 2003 on the December 2002 Draft Report for GM-38 Area Groundwater.

1. **Comment:** The groundwater model constructed by ARCADIS was used to predict both groundwater flow and contaminant transport and ultimately was used to determine the optimal location, pumping rate, and proposed construction (i.e. screen setting) of the groundwater extraction and diffusion wells. Based on the results of modeling conducted by ARCADIS, the two extraction well pumping system and the four diffusion well re-injection gallery are sufficient to achieve the goal of recovering groundwater having TVOCs greater than 500 micrograms per liter (ug/L). It should be clarified in the Draft Basis of Design Report that the model was utilized to develop the proposed remedial design.

   Response: The report on Page 3-1 will be modified to state: "Groundwater extraction rates and wells locations were developed **by Arcadis Geraghty & Miller (AGM)** using a regional groundwater model."

2. **Comment:** It should be noted that the design concentrations and estimated loading rates used in the proposed remedial system design are based on Tetra Tech's method of averaging available groundwater quality data, and not on the ARCADIS groundwater transport modeling. Tetra Tech's method is based on a maximum potential influent concentration (the maximum observed concentration in the aquifer) and a constant average concentration over the entire pumping period. In contrast, the model provides a maximum potential influent (that in this case occurs at start-up) and predicted influent concentration that reduces over time. However, both methodologies likely provide a reasonable estimate of expected concentrations and a worst-case scenario.

   Response: TtNUS agrees that the AGM and TtNUS results are similar, which would be expected because the same data base was used. However, TtNUS does not assume that the loadings will remain constant throughout the project and does expect the influent concentration to change overtime. In the short term, increased concentrations are possible, but in the long term, a decreased concentration is expected.

Also, it is important to note that there is no groundwater quality data in the area of the proposed groundwater recovery wells. As such, the actual concentration of VOCs extracted at the beginning of system operation could be either higher or lower than estimated. Also the screens on the recovery wells should be placed to capture the identified areas of groundwater contamination and not necessarily the most contaminated groundwater depths at the recovery well areas.

3. **Comment:** Predictions made regarding the mounding, the number of diffusion wells, and the re-injection system in general are very preliminary and should be considered estimates at this point. No field tests have been conducted to date. ARCADIS experience has shown that this method of treated-water disposal may not be as simple as presented in the reports. Predictions regarding mounding or the local impact of diffusion wells are very much estimates. Actual local hydrogeologic conditions at potential injection points (if different than simulated) could result in 100% deviation from model predicted values (head) in the immediate vicinity of the injection wells. This is not to say that the model predicted results regarding a lack of potential hydraulic interference between the extraction and injection points is not reliable, rather, it is mentioned to draw attention to the potential shortcomings of model predictions at the very local scale in the vicinity of the injection points.

   Response: TtNUS acknowledges the level of uncertainty associated with the re-injection wells. Based on theoretical calculations, only one injection well would be required. During construction, TtNUS expects that two re-injection wells will be installed initially, but acknowledges that up to four re-injection wells may be required.

4. **Comment:** Alternative treated-water disposal options should be retained for evaluation. If the stormwater system discharge alternative is an option for this remedial design, it may be the best technical approach. Likewise, discharge to a recharge basin should also be re-evaluated. If groundwater re-injection via a diffusion well gallery is retained as the selected technology, it is recommended that a minimum of four diffusion wells be incorporated into the final system design.

   Response: Alternative discharge options have not been ruled out and will be pursued during later stages of the design. In particular, a tie-in to the local sanitary system is planned to handle non-continuous discharges associated with construction (e.g. development water containing solids), startup (liquid phase carbon unit flushing), periodic cleaning of treatment units that may contain suspended solids.

As described in the Conceptual Report, injection wells were selected as the most viable long term option. Continuous discharge of the entire flow to the POTW is not cost effective. Discharge to local recharge basins was not considered to be viable because of administrative issues associated with obtaining approval to discharge, periodic shutdowns during storm events effecting the performance of the system, potentially high costs associated with discharge fees, and long-term basin maintenance and liability concerns.

5. **Comment:** The design influent concentration used in the process calculations does not incorporate an adequate factor of safety to specify a suitable packing depth for the existing air stripper. Applying a safety factor of 2 for the influent groundwater quality, the recommended design influent concentration would be 822 ug/L for TCE (975 ug/L for TVOCs), which is the limiting constituent of concern in the design basis. Assuming an effluent concentration of 2.5 ug/L (50 percent of the MCL for TCE, and consistent with what Northrop Grumman did for the ONCT System) and an ONDA safety factor of 33 percent, the required packing depth (rounded to the nearest foot) for the stripper is 27 feet to achieve a concentration less than effluent design concentration (2.5 ug/L). Therefore, if the existing air stripper configuration is retained, it is recommended that, at a minimum, a guarantee be obtained from the air stripper manufacturer to ensure that the existing stripper performs to the design effluent criteria, as specified. Future modifications to the air stripper system, including extension of the stripper column or installation of influent spray nozzles, may be required if the effluent limits are not achieved.

Response: The remedy as presented is adequately conservative, without the need for applying additional contingency factors. In particular, the air stripping system is flexible and performance can be easily improved for short duration slugs by decreasing water flow rates and/or increasing air flow rates. In addition, as suggested by Foster Wheeler, the system will also include a liquid phase granular activated carbon unit as a contingency to remove any VOCs that may not be removed in the air stripping tower.

6. **Comment:** Drawing P-2, Piping and Instrumentation Diagram (PID), from the Draft Basis for Design Report only indicates a single vapor phase granular activated carbon (GAC) unit, although the text of the document refers to two units. The PID should be revised accordingly to show two GAC units in series, such that either vessel may be operated as the lead (primary) treatment unit. Furthermore, it is recommended that each GAC vessel should include a condensate drain at the base of the unit.

   Response: Based on the relatively low loading rates for VOCs on vapor phase granular activated carbon, a two stage vapor treatment unit is not required. However, space will be provided for a second unit to be used during startup, and then as a contingency measure for vinyl chloride.

   The vapor phase units are anticipated to operate without free moisture, otherwise VOC removal efficiencies decrease significantly. Although the manufacturer will likely provide piping connections near the bottom of the unit, there is no requirement. If moisture does enter the unit, then the blowers operating with clean air and the air heater can be used to dry the media.

7. **Comment:** Tetra Tech has identified vinyl chloride as a COC in the GM-38 Area groundwater. It should be noted that vinyl chloride is not efficiently or cost-effectively removed using vapor phase GAC. Although estimated loading rates indicate that vinyl chloride may be discharged in the effluent stream at a concentration below the applicable limits for this compound, it is recommended that alternative treatment technologies, such as permanganate-impregnated zeolite, be evaluated for final polishing of vinyl chloride, prior to discharge to the atmosphere if treatment of vinyl chloride is required.

   Response: TtNUS expects the system to control vinyl chloride emissions through either additional vapor phase carbon usage, as is currently being done at the ONCT system, or by adjusting groundwater extraction rates to address short-term slugs of the vinyl chloride.

In the event that long term high concentrations of vinyl chloride are encountered, then alternative treatment technologies can be considered.

8. **Comment:** The estimated GAC usage rates appear low for the site COCs. ARCADIS estimates the GAC usage to be approximately 80 pounds per day (not the 47 pounds per day calculated by TTNUS), equivalent to a changeout every 170 days or approximately 6 months. Based on this estimate, the GAC units are still appropriately sized, however more frequent changeouts are anticipated.

   Response: The method that TtNUS used is generally conservative in estimated GAC capacities. In either case, a five- to nine-month carbon change out schedule is reasonable, especially when the peak loading is expected to occur within the first one to two years of operation. In the long term, carbon change out frequency will decrease.

9. **Comment:** It is unclear as to how the air stripper off-gas discharge rate will be monitored. The design basis and PID should indicate the means for the air discharge monitoring.

   Response: Air monitoring methods and requirements will be developed during the air discharge permit application. For this type of system, air flow rates remain relatively constant. It is expected that the flow rate will be measured initially and then periodically during the operation using a portable instrument.

   The concentration of VOCs in the air stripper column discharge is estimated to be relatively low, almost to the point that off-gas treatment is not required. However, regular air quality testing is expected to use portable real-time equipment such as a PID to monitor performance. Less frequently, air samples will be collected and tested for individual VOCs.

10. **Comment:** The incorporation of the sodium hydroxide feed system may be avoided through administrative measures, such as a waiver of this requirement in the groundwater injection permit. ARCADIS experience with similar groundwater treatment systems in this area suggests that pH adjustment may not be required based on the fact that groundwater in the area of the site exhibits a slightly acidic natural pH, a slight rise

in pH would be expected through the treatment process (without the sodium hydroxide system), and, consistent with the influent water quality characteristics, the receiving waters also exhibit a relatively low natural pH. If pH adjustment is incorporated, it is recommended that a flow-paced feed system be considered with a pH control loop incorporated into the treated groundwater discharge line. Furthermore, the sodium hydroxide system will require a separate enclosure and temperature control for storage.

Response: TtNUS agrees that pH adjustment may not be required. The referenced pH rise during treatment usually results from off gassing of carbonate/carbon dioxide. Based on the minimal alkalinity measured in the GM-38 groundwater samples, the amount of carbonate in the groundwater is expected to be very low. The system as proposed, is relatively inexpensive, and also provides limited corrosion protection.

The sodium hydroxide system will be housed within the building, and as such will not require a separate enclosure and temperature control.

The sodium hydroxide feed system will be controlled based on influent flow rate. Based on the expected consistency of the water, a fixed ratio feed, with periodic operator check and adjustment is expected to be adequate for this application. A pH control system as suggested is very complex, and in the absence of adequate buffering in the water (alkalinity/acidity) is subject to control problems.

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GM-38 AREA GROUNDWATER REMEDY ANALYSIS REPORT

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT (NWIRP) BETHPAGE, NEW YORK

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Northeast
Environmental Branch Code EV2
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

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LIST OF ACRONYMS AND ABBREVIATIONS

AGM	Arcadis Geraghty & Miller
AWR	Air-to-water ratio
bgs	Below ground surface
BWD	Bethpage Water District
cfm	Cubic feet per minute
CLEAN	Comprehensive Long-Term Environmental Action Navy
COC	Chemical of concern
CTO	Contract Task Order
DCE	Dichloroethene
Dia.	Diameter
EFANE	Engineering Field Activity North East
°F	Degree Fahrenheit
GAC	Granular activated carbon
gpd	Gallon(s) per day
gpm	Gallon(s) per minute
gpm/ft^2	Gallons per minute per square foot
H	Height
HP	Horsepower
IW	Re-Injection Well
kW	Kilowatt
lbs/day	Pounds per day
LWH	Length x width x height
mg/l	Milligram(s) per liter
µg/L	Microgram(s) per liter
NaOH	Sodium hydroxide or caustic soda
Navy	United States Navy
NWIRP	Naval Weapons Industrial Reserve Plant
NYSDEC	New York States Department of Enviromental Conservation
OU	Operable Unit
PCE	Tetrachloroethene
psig	Pound per square inch gauge
PWSW	Public water supply well
ROD	Record of Decision
RW	Recovery Well
S.U.	Standard unit (pH)

TDH	Total displacement head
TCA	Trichloroethane
TCE	Trichloroethene
TtNUS	Tetra Tech NUS, Inc.
TVOC	Total volatile organic compounds
VC	Vinyl chloride
VOC	Volatile organic compound
VPB	Vertical profile boring

1.0 INTRODUCTION

Tetra Tech NUS, Inc. (TtNUS) was tasked by the United States Navy (Navy) to conduct remedial analysis activities associated with the extraction, treatment, and discharge of contaminated groundwater from a location referred to as the GM-38 Area. The GM-38 Area is approximately 8,500 feet south southeast and hydraulically down gradient of the Naval Weapons Industrial Reserve Plant (NWIRP) Bethpage, as shown on Figures 1-1 and 1-2. This report was prepared for the Navy Engineering Field Activity Northeast (EFANE) Naval Facilities Engineering Command (NAVFAC) under Contract Task Order (CTO) 0812, for the Comprehensive Long-Term Environmental Action Navy (CLEAN) III Contract Number N62472-94-D-0888.

Remediation of the GM-38 Area groundwater is identified in the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) Operable Unit (OU) 2 Groundwater for Site Numbers 1-30-003A & B dated March 2001 (NYS OU2 ROD). GM-38 refers to a cluster of monitoring wells that were installed in the 1990's by Northrop Grumman and that first identified an isolated groundwater contaminant plume in this area. Chlorinated volatile organic compounds (VOCs) were identified in moderately deep groundwater [220 to 470 feet below ground surface (bgs)] at concentrations greater than 500 micrograms per liter (µg/l). The contaminated groundwater in the area represents a relatively large mass of chlorinated VOCs that would remain for extended periods and could adversely effect public water supplies in the area, as well as other down gradient water supplies. Two public water supply systems are present in the general area and extract groundwater at depths ranging from 540 to 740 feet bgs. Navy and contractor funded systems are in place at the public water supply wells to remove VOCs from the water prior to distribution.

This report presents the preliminary analysis activities that are intended to establish baseline conditions, an initial remedy development, and cost estimate. Design, construction, and operation and maintenance activities will be conducted by the Navy, through a separate contract.

This report is divided into six sections. Section 1.0 is this Introduction. Section 2.0 presents the Remedial Objectives. The Remedial System Basis is provided in Section 3.0 and the Remedial System Description is provided in Section 4.0. Section 5.0 provides the Equipment Analysis and Section 6.0 provides the schedule.

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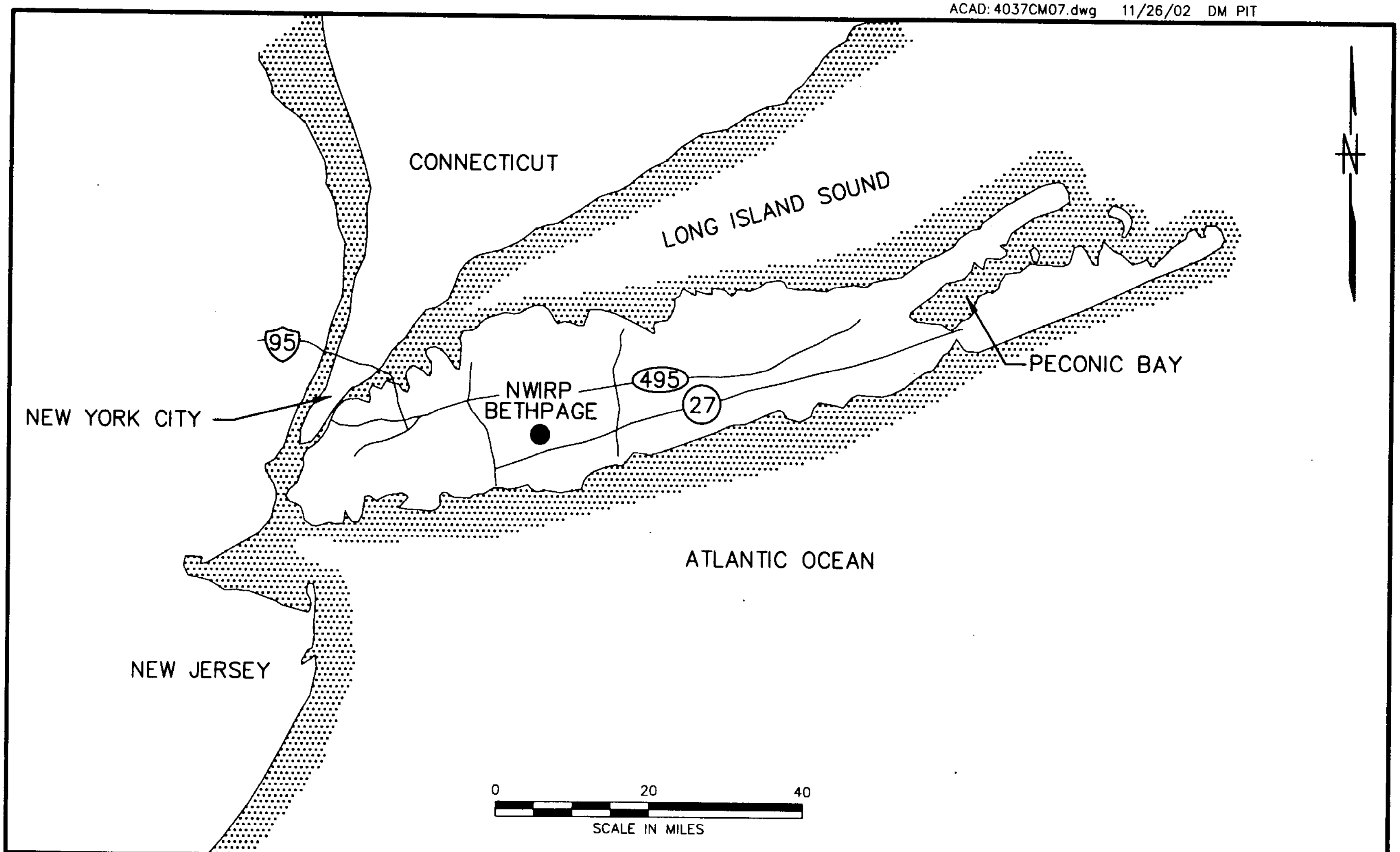

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CHECKED BY	DATE	**GENERAL LOCATION MAP NAVAL WEAPONS INDUSTRIAL RESERVE PLANT NWIRP BETHPAGE BETHPAGE, NEW YORK**	APPROVED BY	DATE
COST/SCHED-AREA			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1-1	REV. 0

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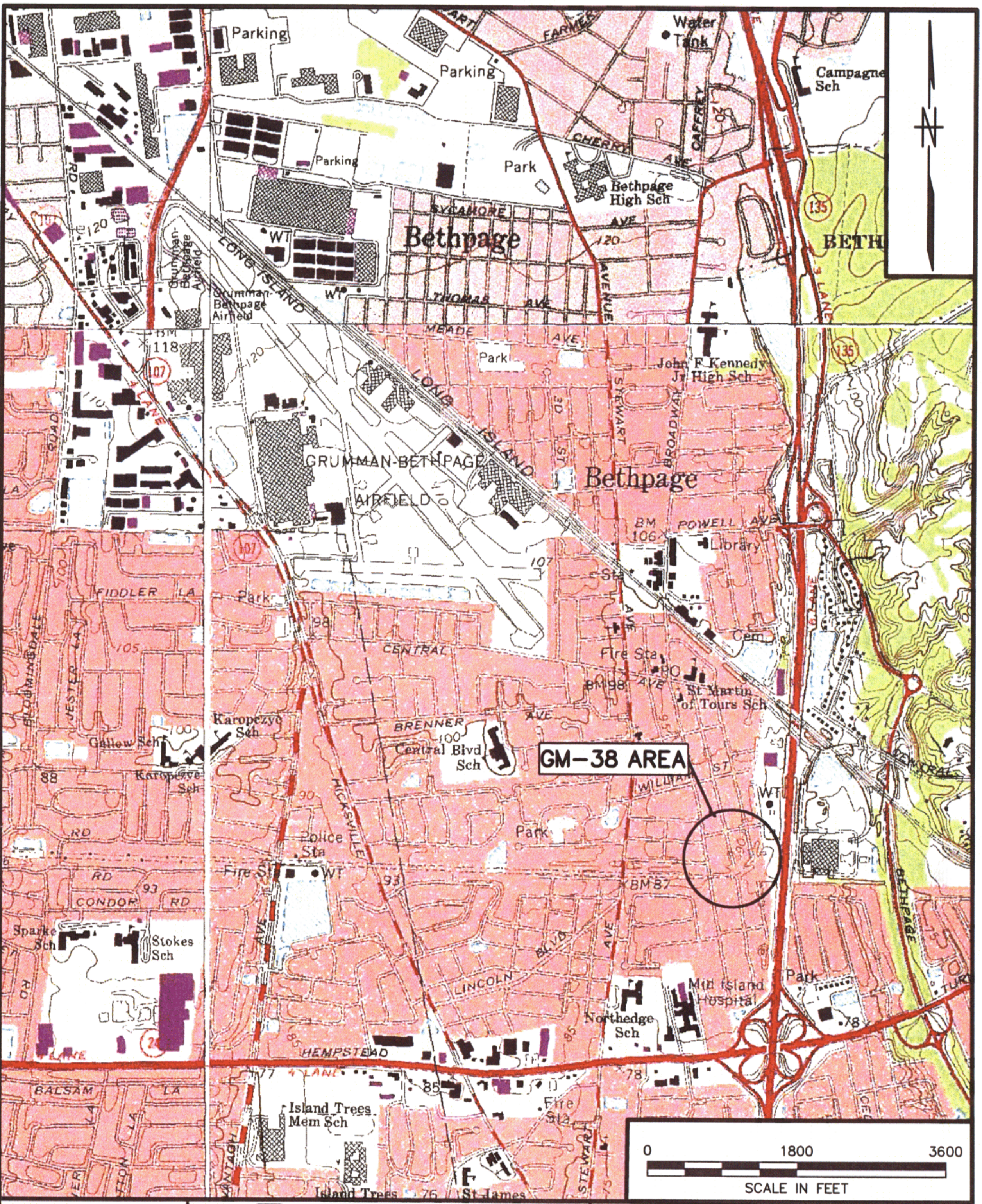

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SCALE AS NOTED		DRAWING NO. FIGURE 1-2	REV. 0

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2.0 REMEDIAL OBJECTIVES

The parameters utilized for the development of this analysis are based upon the New York State Department of Environmental Conservation (NYSDEC) Record of Decision (ROD) (NYSDEC, 2001) and the recommendations of the Conceptual Report (TtNUS, 2002).

2.1 OBJECTIVE

As stated in the ROD, the objective of the off-site GM38 Area remedy is to: “Eliminate, to the extent practical, site-related contaminants from the affected public water supplies and to prevent, to the extent practical, the future contamination of public water supplies through the implementation of the offsite groundwater remediation.”

Although not specifically defined in the NYSDEC OU2 ROD, the GM-38 area groundwater remedy will address groundwater in the area with concentrations of total VOCs (TVOCs) greater than 500 µg/l. The individual site-related VOCs to be addressed include tetrachloroethene (PCE), trichloroethene (TCE), 1,2-dichloroethene (DCE), 1,1,1-trichloroethane (TCA), vinyl chloride (VC), and other related chlorinated solvents.

The purpose of this Analysis Report is to describe the groundwater extraction and treatment system to be constructed to meet this objective and to provide a basis and calculations for each discipline.

2.2 REMEDIAL SCOPE

To define the extent of groundwater contamination in the GM-38 area, seven vertical profile borings (VPB) were installed from June 2000 to April 2002 (VPB-38, -40, -42, -47, -51, and –77), with the results from the initial borings used to locate later borings. The borings were installed to depths ranging from 540 feet to 832 feet bgs. The locations of the vertical profile borings are presented on Figure 2-1. Soil and water groundwater samples were collected on 20- to 50-foot vertical intervals from ground surface to 200 feet bgs and then on 10- to 20-foot vertical centers to the bottom of the boring. Soil samples were used for geological evaluations. Lithology was also identified using a continuous gamma log from the bottom of the boring to the surface. Groundwater samples were analyzed for VOCs at a fixed base laboratory, plus as sample volume permitted, field parameters including dissolved oxygen, specific conductivity, pH, temperature, and turbidity.

Data from permanent monitoring well clusters located north and west and hydraulically upgradient of the GM-38 Area were also used in developing the isoconcentration contours presented in Figure 2-1. Groundwater samples from these monitoring wells contained a maximum concentration of 32 µg/l TVOCs.

VOCs were detected in groundwater samples in all 7 borings; however, TVOCs were detected at concentrations greater than 500 µg/l in only 3 of the 7 borings (VPB-38, -47, and –51). Data from the other 4 borings was used to estimate the location of the 500 µg/l isoconcentration contour line. Figure 2-1 also presents the maximum TVOC concentration detected in each boring. Summary statistics for these three borings are summarized as follows.

Parameter	VPB-38	VPB-47	VPB-51
Max. TVOC concentration (µg/l)	3,420	945	3,144
Max. VOC – concentration (µg/l)	TCE – 3,400	TCE – 770	DCE – 1,100
Depth VOCs > 500 µg/l (feet bgs)	250 to 470	340 to 400	220 to 240
Frequency VOCs > 500 µg/l	18 of 33	2 of 25	2 of 28

The extent of the GM-38 Area was estimated using two separate methods. The first method was based on the maximum TVOC detected in each sample in a boring. This method provides an outer boundary for the GM-38 Area. The second method was based on the maximum average TVOC concentration within a computer model layer in a boring. Because the computer model layer estimate incorporates the thickness of contamination, this method identifies the area where the greatest mass of contamination is present. In the GM-38 Area, the models layers are approximately 100 feet thick. The two sets of TVOC isoconcentration contours at the 500 µg/l and 1000 µg/l concentrations are presented on Figure 2-1.

The horizontal extent of contamination in the GM-38 Area (TVOC concentration greater than 500 µg/l in individual samples) was estimated to total approximately 67 acres, and be centered in the area of the split between North and South Windhorst Avenue, see Figure 2-1. The split between North and South Windhorst Avenues is a piece of vacant land resulting from the presence of a high voltage power transmission line.

The vertical extent of contamination in the GM-38 Area (TVOC concentration greater than 500 µg/l in individual samples) ranges from approximately 40 feet thick at VPB-51 to 230 feet thick at VPB-38. The depth of contamination in the GM-38 Area ranges from 240 feet to 470 feet below ground surface.

Model layer depths, individual sample data, and model layer average concentrations calculations are presented in Appendix A. The contours presented in Figure 2-1 are estimated using logarithmic averaging of the maximum TVOC concentrations within each boring with data from all seven borings. Based on the vertical profile boring program, VPB-38, -47, and –51 are within the 500 µg/l isoconcentration contour, whereas VPB-40, -42, -48, and –77 are outside of the 500 µg/l isoconcentration contour. Capture of individual sample intervals with TVOCs greater than 500 µg/l will be confirmed during the analysis of the capture areas. Cross sections of the area of interest showing lithology and chemistry data are presented on Figures 2-2 and 2-3.

Based on surface area, average plume thickness, and TVOC concentrations, the GM-38 Area effects approximately 450 million gallons of groundwater that contain 3,300 pounds of soluble TVOCs. Theoretical adsorption of groundwater contaminants onto aquifer sediments may result in an additional 2,500 pounds of TVOCs in this area, for a total estimated mass of 5,800 pounds of TVOCs, see Appendix A.

The goal of the remediation system will be to extract the contaminated groundwater in the GM-38 Area to such a time that the quality of the remaining groundwater is similar to or less than quality of the remaining off site groundwater. The determination to shut down the system will be made by the Navy, in consultation with New York State Department of Environmental Conservation. As a minimum, the system will operate for a period of 5 years or until the TVOC concentrations in the GM-38 Area groundwater are at or below 500 µg/l. In the event that effective removal of VOCs is continuing and TVOC concentrations in individual monitoring wells are continuing to decrease, the Navy may continue to operate the system until TVOC concentrations in individual monitoring wells and the recovery wells are at or below 100 µg/l, but for a period of no longer than 10 years. Also, during operation, the Navy may shut down one well and/or modify extraction rates to optimize performance.

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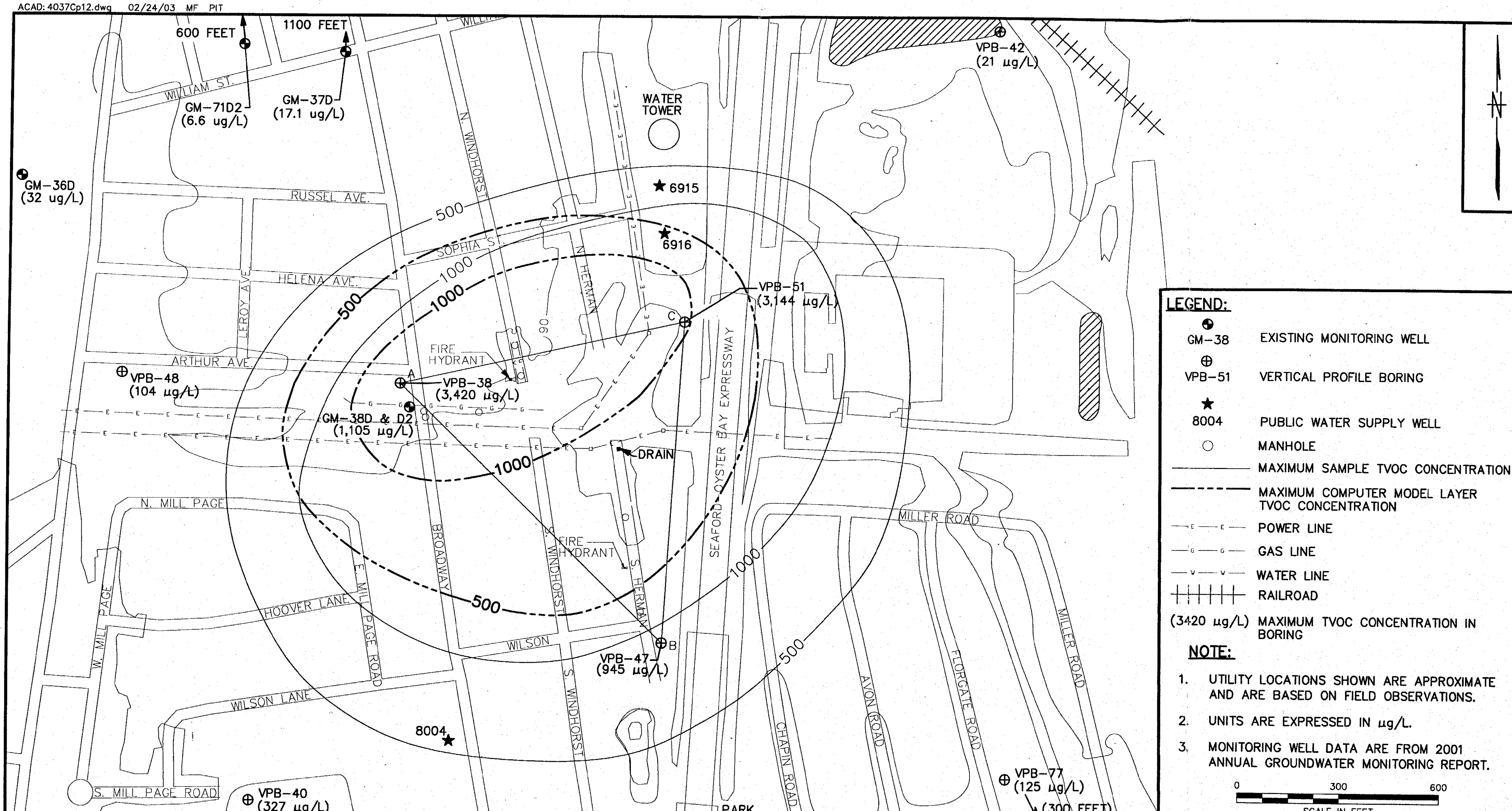

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SCALE AS NOTED

Tetra Tech NUS, Inc.

MAXIMUM TOTAL VOLATILE ORGANIC COMPOUND CONCENTRTIONS
OFFSITE GM-38 AREA REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037
OWNER NO. ——
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DRAWING NO. FIGURE 2-1
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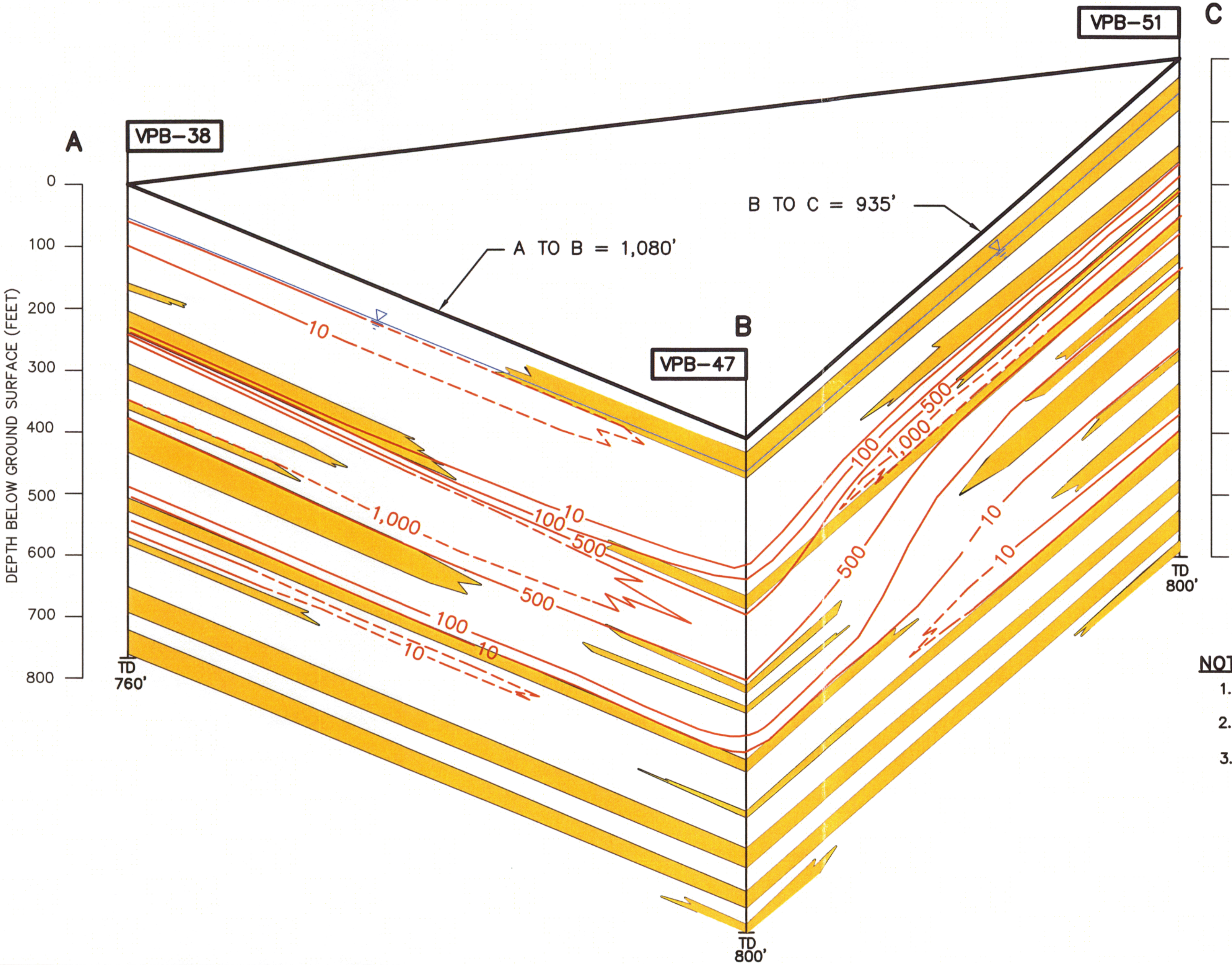

LEGEND:

- WELL OR SOIL BORING IDENTIFICATION — VPB-38
- GROUND SURFACE
- WATER LEVEL (APPROXIMATE)
- CLAY LAYER
- TOTAL VOCs ISOCONCENTRATION CONTOUR, ug/L (DASHED WHERE INFERRED) — 10
- TOTAL DEPTH (FT. bgs) — TD 800'

FT. bgs FEET BELOW GROUND SURFACE

NOTES:

1. GROUND SURFACE ELEVATIONS ASSUMED TO BE APPROXIMATELY 90 FT. MSL.
2. VIEW IS A 60° PROJECTION FROM VERTICAL, LOOKING NORTH.
3. LITHOLOGIC CONTACTS ARE APPROXIMATE AND ARE BASED ON INTERPRETATIONS OF NATURAL GAMMA LOGS. ORANGE COLORED UNITS ARE INTERPRETED AS PREDOMINANTLY CLAYEY DEPOSITS. NON-COLORED ZONES REPRESENT SUBSURFACE UNITS COMPRISED PRIMARILY OF SANDS.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 9/11/02	Tetra Tech NUS, Inc.	CONTRACT NO. 4037	OWNER NO. ----
CHECKED BY DATE	TOTAL VOCs ISOCONCENTRATION CONTOURS CROSS SECTION A-B-C OFFSITE GM-38 AREA REMEDY NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 2-2	REV. 0

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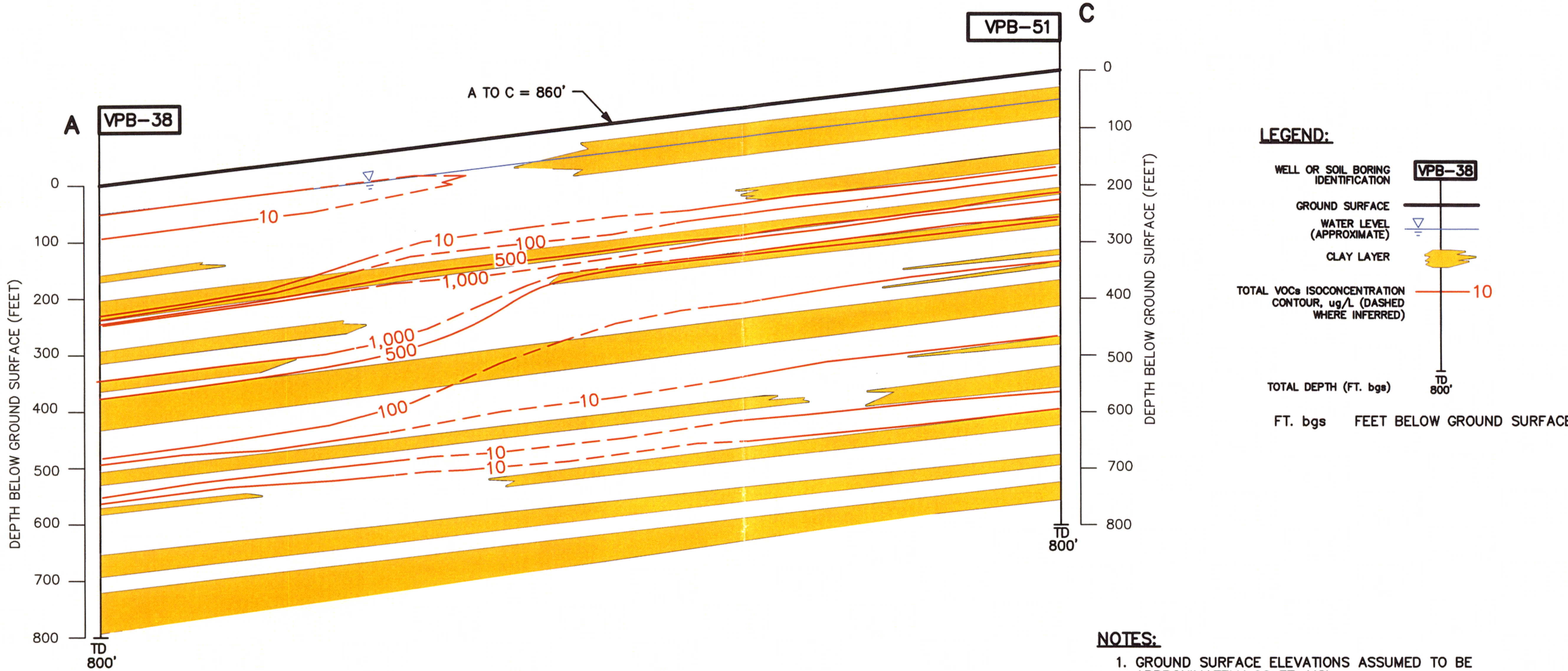

NOTES:

1. GROUND SURFACE ELEVATIONS ASSUMED TO BE APPROXIMATELY 90 FT. MSL.
2. VIEW IS A 60° PROJECTION FROM VERTICAL, LOOKING NORTH.
3. LITHOLOGIC CONTACTS ARE APPROXIMATE AND ARE BASED ON INTERPRETATIONS OF NATURAL GAMMA LOGS. ORANGE COLORED UNITS ARE INTERPRETED AS PREDOMINANTLY CLAYEY DEPOSITS. NON-COLORED ZONES REPRESENT SUBSURFACE UNITS COMPRISED PRIMARILY OF SANDS.

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SCALE: AS NOTED	

Tetra Tech NUS, Inc.

TOTAL VOCs ISOCONCENTRATION CONTOURS
PROFILE A-C
OFFSITE GM-38 AREA REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037	OWNER NO. ————
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3.0 REMEDIAL SYSTEM BASIS

This section provides the basis for establishing groundwater extraction rates, the quality of extracted groundwater, and the need for groundwater treatment prior to discharge. Because the area of concern is a densely populated residential neighborhood with limited open space, final locations for groundwater extraction wells, water transport, treatment equipment, and re-injection wells are primary analysis criteria.

3.1 DEVELOPMENT OF THE GROUNDWATER EXTRACTION SYSTEM

Groundwater extraction rates and well locations were developed by Arcadis Geraghty & Miller (AGM) using a regional groundwater model. The model uses a finite element method to establish optimum extraction locations, depths, and rates to effectively intercept GM-38 Area contaminated groundwater, and minimize capture of clean groundwater. Details on the model and model output are provided in Appendix B. The model run simulation assumes that the Bethpage Water District (BWD) would continue to operate public water supply wells (PWSWs) 6915, 6916, and 8008 at current rates and that the extracted groundwater would be reinjected in the area of vertical profile boring VPB-47.

A two recovery well system was selected for this remediation system, as illustrated on Figures 3-1, 3-2, and 3-3. Horizontal and vertical capture zones for these wells are also presented on these figures. Recovery Well 1 (RW-1) would be located approximately 500 feet down gradient of the approximate center of the GM-38 Area. This recovery well was developed to capture contaminated groundwater from a depth of approximately 435 feet bgs to ground surface. Based on the computer model simulation, over a 5-year period, this extraction well would capture groundwater from a distance of approximately 800 to 1050 feet from the well and an area of approximately 65 acres. Operation of this recovery well beyond 5 years, or at a higher extraction rate would increase the capture zone accordingly. This well would capture the downgradient edge of the GM-38 Area groundwater.

Recovery Well 2 (RW-2) would be located in the approximate geographic center of the GM-38 Area and was developed to capture contaminated groundwater from a depth of approximately 440 to 510 feet bgs. Over a 5-year period, this extraction well would capture groundwater from a distance of approximately 950 feet from the well, and an area of approximately 65 acres. The capture zone for this well is centered approximately 500 feet north of the RW-1 capture zone. Because this well extracts groundwater from a locally confined unit, in the event that operation continues beyond 5 years, the capture area would continue to increase accordingly. Preliminary criteria for these wells are summarized as follows.

Parameter	RW-1	RW-2
Screened Interval (feet bgs)	355 to 435	440 to 510
Well Diameter (inches)	12	12
Extraction Rate (gpm)	800	300
TVOC Concentration (µg/l)	566	277
Initial TVOC Loading (lb/day)	5.4	1.0

gpm – gallons per minute
lb/day – pounds per day VOCs

To evaluate potential uncertainty in the GM-38 Area aquifer characteristics, capture zone calculations were performed using hydraulic conductivities ranging from 25 feet per day to 100 feet per day and effective aquifer thickness increasing from 300 feet to 450 feet for recovery well RW-1 and 100 feet to 200 feet for recovery well RW-2. The larger values for aquifer conductivities and aquifer thicknesses have the effect of decreasing the effective hydraulic down gradient and side gradient capture zones. Calculations to estimate the range of capture zones at the planned flow rates are presented in Appendix C and the results are summarized as follows.

Scenario	RW-1		RW-2	
	Computer Model - 5 year period	Range (Equilibrium)	Computer Model - 5 year period	Range (Equilibrium)
Capture Zone Width at Well (feet)	1,900	780 to 4,700	1,900	660 to 5,300
Capture Zone - Down gradient (feet)	820	250 to 1,500	850	210 to 1,700

This analysis indicates that the computer model provides a reasonable mid range estimate of anticipated capture zones. In the event that actual hydraulic conductivities and effective aquifer thicknesses are higher than anticipated, then higher pumping rates, longer periods of operation, and/or additional extraction wells may be required. However, the exact hydraulic conductivities and effective aquifer thicknesses in the GM-38 Area cannot be accurately determined until a large scale system is in place and operating for a period of time. Also of note is that the extent of groundwater contamination is estimated, and the actual extent of the GM-38 Area groundwater may be larger or smaller than presented.

3.2 GROUNDWATER COMPOSITION AND SYSTEM PERFORMANCE REQUIREMENTS

Average concentrations of chemicals of concern (COCs) in the groundwater extracted by each of the two extraction wells (RW-1, RW-2) are anticipated to be the mathematical average of the concentrations detected at the vertical profile boring sample locations surrounding each of these wells (VPB-38, VPB-47, and VPB-51 for RW-1; VPB-38 and VPB-51 for RW-2). Overall average concentrations of COCs in the extracted groundwater is anticipated to the average of the concentrations calculated for each extraction well pro-rated for the extraction rate of that well. Average concentrations of groundwater COCs are summarized on Table 3-1.

Overall maximum concentrations of COCs in the extracted groundwater are assumed to be equal to the maximum concentrations detected at any of the sampling location surrounding the extraction wells. Maximum concentrations of groundwater COCs are summarized on Table 3-2.

The concentration and type of VOCs entering the recovery wells are expected to vary over time. The well locations were established to allow the efficient capture contaminated groundwater from the entire GM-38 Area, and as such, will not necessarily capture the most contaminated groundwater during the initial operation. Based on the existing data, TVOC concentrations in groundwater initially entering recovery wells RW-1 and RW-2 are expected to average approximately 100 μg/l and 20 μg/l, respectively (See Figures 3-2 and 3-3). The TVOC concentration in these wells are then expected to increase slowly over time as groundwater from boring locations VPB-38 and VPB-51 areas are captured by the recovery wells. The peak TVOC concentrations in RW-1 and RW-2 are anticipated to be at concentrations of 566 μg/l and 277 μg/l, respectively, and should not occur until after one to two years of operation.

After approximately two to three years of operation, when the majority of contaminant mass has been removed from the area, the concentrations of TVOCs in the recovery wells are expected to decrease accordingly.

In addition to VOCs, sampling conducted at GM-38 well cluster indicated that the pH of the extracted groundwater is lower than general standards required for injection into the groundwater. Based on the relatively low pH of the groundwater [5.5 standard units (S.U.)] and lack of hardness, the groundwater is classified as relatively aggressive to metal. As such a simple alkali feed system will be used to neutralize the acid in the groundwater. The need for a pH control system for injection will be re-evaluated during the permit process.

Except for start-up, suspended solids were not identified to be a regulatory concern for the extracted groundwater. A similar groundwater extraction and treatment system operates on site without suspended solids control measures. Since this onsite system discharges to surface recharge basins, a low concentration of suspended solids can be tolerated. However, because the treated GM-38 Area groundwater will be discharged through re-injection wells, pre-filtration of the groundwater will be required during the initial startup of the system and may be required during the long term operation. Because the suspended solids loading is expected to be very low, (less than 7 pounds per day), flow through bag type filtration will be used.

3.3 TREATMENT OBJECTIVE

The preliminary treatment objective for the off-site GM-38 Area remedy is to remove VOCs to meet the compliance levels shown on Table 3-3. The treatment equipment will be sized to treat the average concentration of individual VOCs to 0.5 µg/l or less and the maximum concentration of VOCs in the GM-38 Area to New York State Groundwater Water Standards (2 to 5 µg/l). Final treatment objectives will be determined during the groundwater injection permit process.

3.4 DEVELOPMENT OF REINJECTION SYSTEM

The location of the treated GM-38 Area groundwater re-injection system has been selected: to be close to the groundwater extraction and treatment area to limit piping costs; to minimize interference with the effective capture of contaminated groundwater; and to minimize potential interference with the operation of local public water supply wells.

An open area near vertical profile boring VPB-47 and the southern end of South Herman Avenue was selected, see Figure 3-1. The groundwater would be reintroduced in the shallow portion (upper 150 feet) of the aquifer that is relatively clean (1 to 10 µg/l TVOCs). This location represents the closest open area that is near the down gradient edge of the GM-38 Area groundwater. Computer modeling simulations were conducted to evaluate potential impacts, see Appendix B. The modeling results suggest that re-injection of groundwater at this location would not have an adverse effect on either the capture zones for the recovery wells or the local water districts.

The designated groundwater re-injection area (approximately 0.12 acres) is adequately sized to handle the anticipated number of required injection wells (two to four). But if additional re-injection wells or spacing between wells are required, then adjacent town roadway – South Herman and New York State highway property – Seaford Oyster Bay Expressway would be considered.

TABLE 3-1

AVERAGE GROUNDWATER CONCENTRATIONS
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NEW YORK

COC	RW-1		RW-2		Overall Concentration[1] (µg/L)
	Concentration (µg/L)	Factor	Concentration (µg/L)	Factor	
Vinyl Chloride	6.5	0.73	0.1	0.27	4.8
1,1-Dichloroethene	2.0	0.73	0.6	0.27	1.6
1,1-Dichloroethane	0.8	0.73	0.3	0.27	0.7
1,2-Dichloroethene	41.8	0.73	3.5	0.27	31.5
Chloroform	1.0	0.73	0.4	0.27	0.8
1,2-Dichloroethane	1.2	0.73	0.3	0.27	1.0
1,1,1-Trichloroethane	4.1	0.73	0	0.27	3.0
Carbon Tetrachloride	0.1	0.73	0	0.27	0.1
1,1,2-Trichloroethane	0.3	0.73	0.4	0.27	0.3
Benzene	0.1	0.73	0	0.27	0.1
Tetrachloroethene	45.8	0.73	1.3	0.27	33.8
Toluene	1.0	0.73	0	0.27	0.7
Chlorobenzene	0.1	0.73	0	0.27	0.1
Xylenes	0.3	0.73	0	0.27	0.2
Methyl Tert Butyl Ether	0.2	0.73	0	0.27	0.1
Trichloroethene	461.1	0.73	277.3	0.27	411.5
Total VOCs	566.4	0.73	284.2	0.27	490.2

<u>Note</u>:

1 Rounded to the next higher decimal.

TABLE 3-2

MAXIMUM GROUNDWATER CONCENTRATIONS
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NEW YORK

COC	Maximum Concentration (µg/L)	Detection Location
Vinyl Chloride	300	VPB-51
1,1-Dichloroethene	9	VPB-51
1,1-Dichloroethane	4	VPB-51
1,2-Dichloroethene	1,100	VPB-51
Chloroform	2	VPB-38
1,2-Dichloroethane	3	VPB-38
1,1,1-Trichloroethane	3	VPB-38
Tetrachloroethene	900	VPB-51
Chlorobenzene	1	VPB-51
Methyl Tert Butyl Ether	2	VPB-38
Trichloroethene	3,400	VPB-38
Total VOCs	3,420	VPB-38

TABLE 3-3

GROUNDWATER TREATMENT OBJECTIVES
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NEW YORK

Chemical of Concern	Treatment Objective (μg/L)	
	Average Concentration	Maximum Concentration
Vinyl Chloride	0.5	2
1,1-Dichloroethene	0.5	5
1,1-Dichloroethane	0.5	5
1,2-Dichloroethene	0.5	5
Chloroform	0.5	5
1,2-Dichloroethane	0.5	5
1,1,1-Trichloroethane	0.5	5
Tetrachloroethene	0.5	5
Chlorobenzene	0.5	5
Methyl Tert Butyl Ether	0.5	5
Trichloroethene	0.5	5

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NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

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SCALE AS NOTED

Tetra Tech NUS, Inc.

RECOVERY WELL CAPTURE ZONE AND TOTAL VOLATILE ORGANIC COMPOUNDS – ISOCONCENTRATION CONTOURS
OFFSITE GM-38 AREA REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037
OWNER NO. ——
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 3-1
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98

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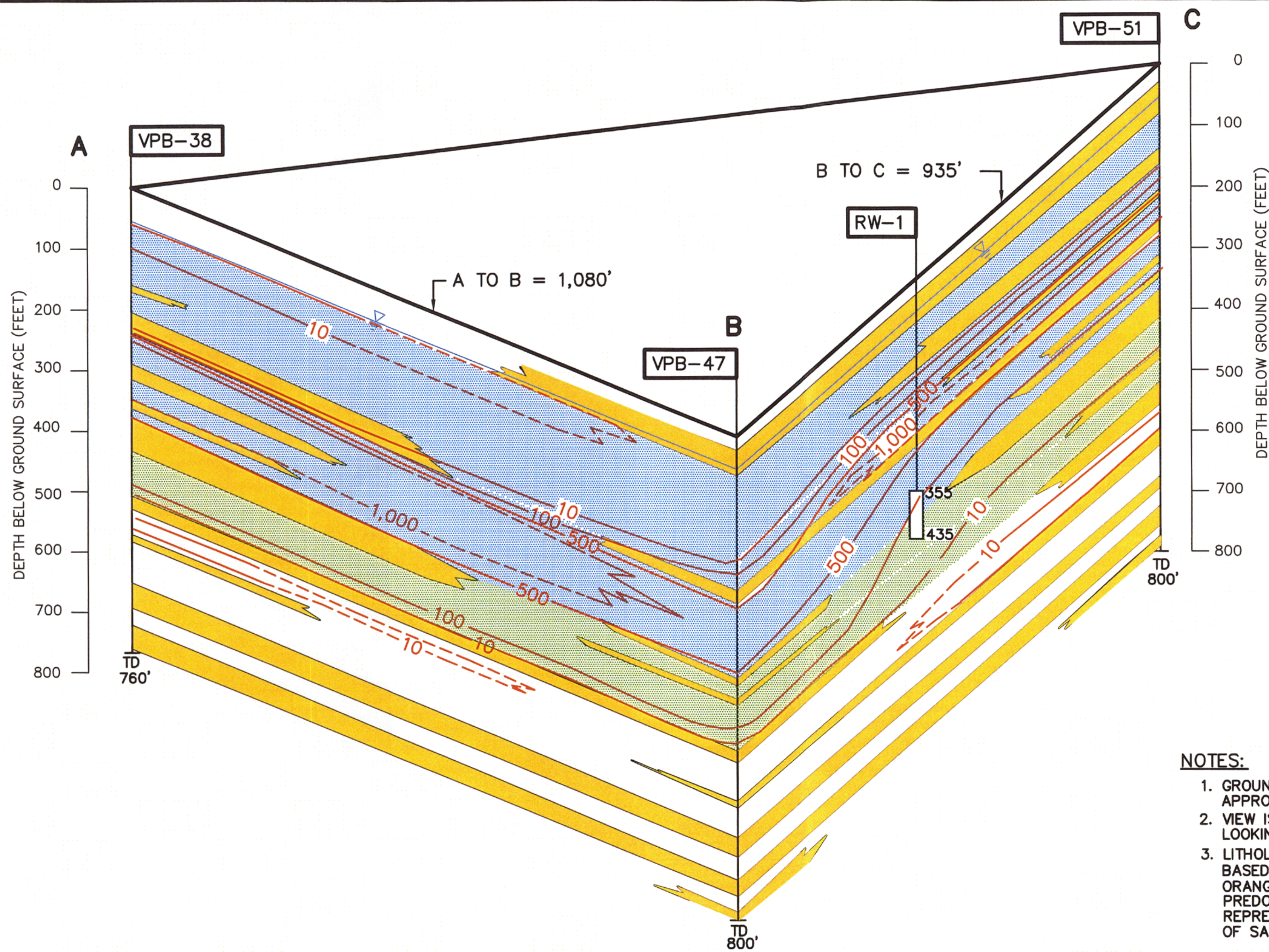


LEGEND:

WELL OR SOIL BORING IDENTIFICATION — RW-1

GROUND SURFACE

WATER LEVEL (APPROXIMATE)

CLAY LAYER

TOTAL VOCs ISOCONCENTRATION CONTOUR, ug/L (DASHED WHERE INFERRED) — 10

TOP OF SCREEN (FT. bgs) — 355

BOTTOM OF SCREEN (FT. bgs) — 435

TOTAL DEPTH (FT. bgs) — TD 800'

RW-1 CAPTURE AREA BASED ON AGM MODELING (5 PLUS YEARS)

RW-2 CAPTURE AREA BASED ON AGM MODELING (5 PLUS YEARS)

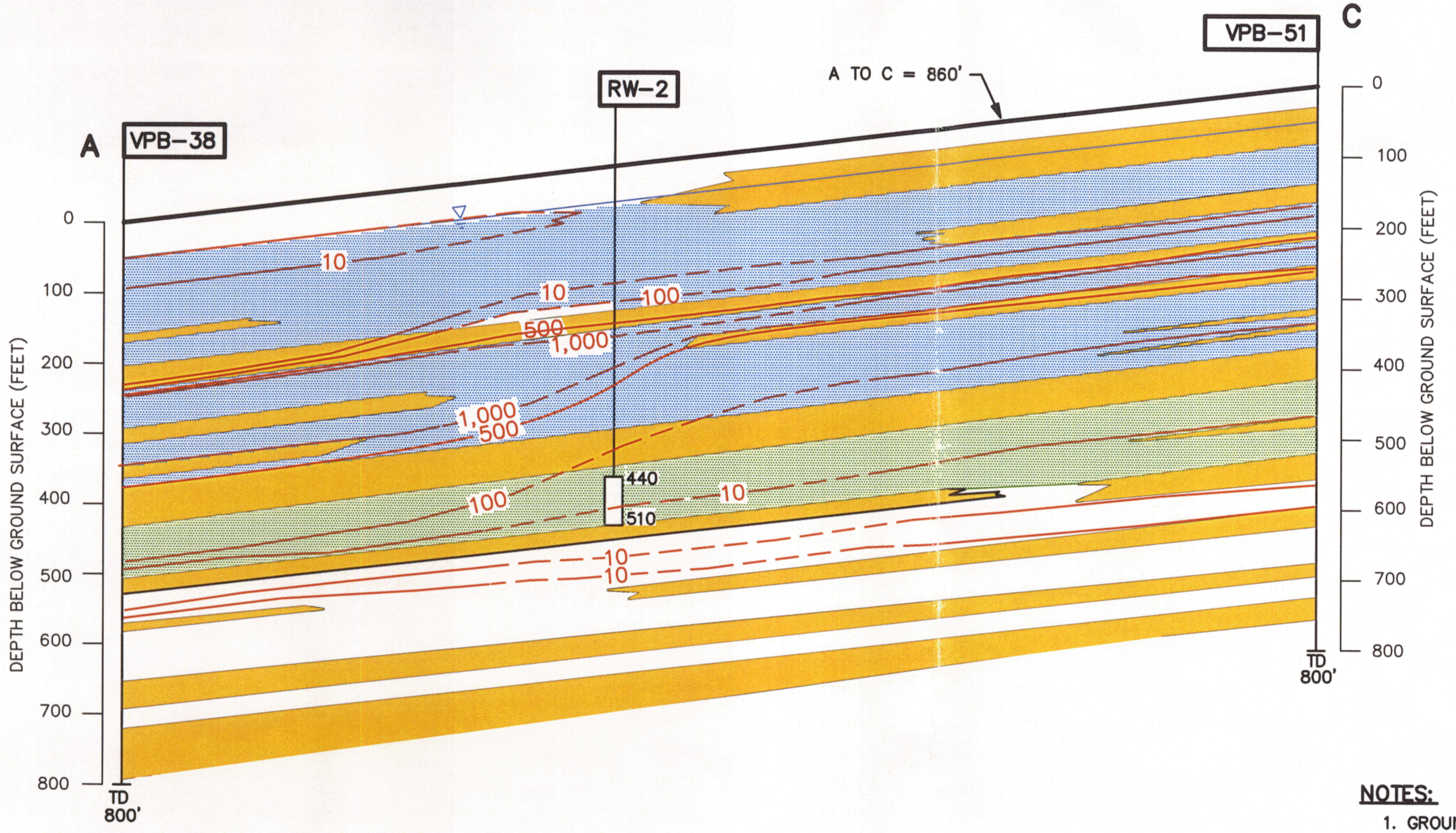
FT. bgs — FEET BELOW GROUND SURFACE

NOTES:

1. GROUND SURFACE ELEVATIONS ASSUMED TO BE APPROXIMATELY 90 FT. MSL.
2. VIEW IS A 60° PROJECTION FROM VERTICAL, LOOKING NORTH.
3. LITHOLOGIC CONTACTS ARE APPROXIMATE AND ARE BASED ON INTERPRETATIONS OF NATURAL GAMMA LOGS. ORANGE COLORED UNITS ARE INTERPRETED AS PREDOMINANTLY CLAYEY DEPOSITS. NON-COLORED ZONES REPRESENT SUBSURFACE UNITS COMPRISED PRIMARILY OF SANDS.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 9/11/02	Tetra Tech NUS, Inc.	CONTRACT NO. 4037	OWNER NO. ———
CHECKED BY DATE	RW-1 CAPTURE ZONE CROSS SECTION A-B-C OFFSITE GM-38 AREA REMEDY NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 3-2	REV. 0



LEGEND:

WELL OR SOIL BORING IDENTIFICATION — RW-2

GROUND SURFACE

WATER LEVEL (APPROXIMATE)

CLAY LAYER

TOTAL VOCs ISOCONCENTRATION CONTOUR, ug/L (DASHED WHERE INFERRED) — 10

TOP OF SCREEN (FT. bgs) — 440

BOTTOM OF SCREEN (FT. bgs) — 510

TOTAL DEPTH (FT. bgs) — TD 800'

RW-1 CAPTURE AREA BASED ON AGM MODELING (5 PLUS YEARS)

RW-2 CAPTURE AREA BASED ON AGM MODELING (5 PLUS YEARS)

FT. bgs — FEET BELOW GROUND SURFACE

NOTES:

1. GROUND SURFACE ELEVATIONS ASSUMED TO BE APPROXIMATELY 90 FT. MSL.
2. VIEW IS A 60° PROJECTION FROM VERTICAL, LOOKING NORTH.
3. LITHOLOGIC CONTACTS ARE APPROXIMATE AND ARE BASED ON INTERPRETATIONS OF NATURAL GAMMA LOGS. ORANGE COLORED UNITS ARE INTERPRETED AS PREDOMINANTLY CLAYEY DEPOSITS. NON-COLORED ZONES REPRESENT SUBSURFACE UNITS COMPRISED PRIMARILY OF SANDS.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM — DATE 9/11/02
CHECKED BY — DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

RW-2 CAPTURE ZONE
PROFILE A-C
OFFSITE GM-38 AREA REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037 — OWNER NO. ----
APPROVED BY — DATE
APPROVED BY — DATE
DRAWING NO. FIGURE 3-3 — REV. 0

4.0 REMEDIAL SYSTEM DESCRIPTION

4.1 GENERAL PROCESS DESCRIPTION

The offsite GM-38 Area remedy groundwater extraction and treatment system includes the following unit processes:

- Groundwater extraction
- Air stripping and offgas treatment
- Granular activated carbon polishing
- Filtration
- Treated groundwater re-injection

The purpose of this section is to provide a general description of these unit processes and to identify key process parameters. Please, also refer to the process flow diagram and mass balance drawing (Drawing P-1) and the site layout plot (Drawing C-1). Process calculations are presented in Appendix C.

4.1.1 <u>Groundwater Extraction</u>

Groundwater extraction is performed using two Recovery Wells (RW), RW-1 and RW-2. Sizing criteria for these wells are summarized as follows.

Parameter	RW-1	RW-2
Screened Interval (feet bgs)	355 to 435	440 to 510
Well Diameter (inches)	12	12
Extraction Rate (gpm)	800	300
TVOC Concentration (µg/L)	566	277
Initial TVOC Loading (lb/day)	5.4	1.0

gpm: gallons per minute
lb/day: pounds per day VOCs
µg/L: micrograms per liter

4.1.2 <u>Air Stripping and Offgas Treatment</u>

Air stripping is a process in which groundwater containing volatile contaminants is brought into contact with a large volume of air, which causes these contaminants to volatilize into the air stream and subsequently be carried away. Usually, the contact takes place in a column containing packing or trays for the purpose of improving gas/liquid contact. Packed columns are commonly used for groundwater remediation because they provide a high efficiency for the removal of VOCs. Groundwater flows downward through the column while air rises upward from near the bottom of the column.

Contaminants with low water solubility and high vapor pressures are amenable to air stripping. For low concentrations of contaminants in water, Henry's Law coefficients serve as a measure of determining whether or not a contaminant is capable of being stripped. Compounds with Henry's law constants greater than $2x10^{-3}$ atm m3/mole can be air stripped, with resultant removal efficiencies of greater than 99 percent. All of the offsite GM-38 Area COCs (TCE; PCE, 1,2-DCE, 1,1,1 TCA; 1,1 DCA; 1,2 DCA; and 1,1 DCE) are amenable to air stripping. Based on both average and maximum anticipated concentrations and treatment criteria, TCE was found to be size-limiting.

Key process parameters that determine an air stripping column removal efficiency for a given groundwater quality are air to water flow ratio (AWR), packing medium depth and type, and flux rate expressed in gallons per minute per square foot (gpm/ft2). For the offsite GM-38 Area remedy, an existing air stripping column from the NWIRP Bethpage will be re-used. This existing column will be equipped with a new 7,350 cubic feet per minute (cfm) air blower to provide an AWR of 50:1. The existing air stripping column is 10 feet in diameter with a 25-foot depth of Jaeger Tripack packing medium, which corresponds to a flux rate of 14 gpm/ft2 at the flow of 1,100 gpm. The minimum groundwater temperature is 55 degrees Fahrenheit (°F). Hydraulically, the existing air stripper can handle a total water flow rate of up to approximately 5,500 gpm. However, as the water flow rate increases, VOC removal efficiencies decrease.

Prior to air stripping, the pH of the extracted groundwater will be adjusted from its typical value of 5.5 to approximately 7.0 S.U. (6.5 to 8.5) to reduce corrosion concerns and to achieve a neutral pH for reinjection into the aquifer. This will be done with in-line injection of sodium hydroxide.

A vapor-phase granular activated carbon (GAC) adsorption system is provided to remove VOCs from the offgas of the air stripper prior to discharge to atmosphere. Prior to entering the vapor-phase GAC adsorption system, the humidity of the air stripper exhaust is reduced to approximately 50 percent or less by a 75 kilowatt (kW) electric off gas heater to optimize the efficiency of the vapor-phase GAC.

4.1.3 Granular Activated Carbon Polishing

Granular activated carbon (GAC) polishing is a process in which groundwater is passed through a fixed bed containing a carbon-based media. Carbon has the ability to adsorb many organic compounds, including most of the site contaminants. The carbon-based media is thermally enhanced (activated) to increase available surface area and thereby promote the adsorption process. Several site contaminants including PCE and TCE are readily adsorbed onto the carbon media. Other site contaminants (except vinyl chloride) are also adsorbed, but not as well as PCE and TCE. Chemicals such as vinyl chloride are not adsorbed very well on to GAC.

During operation of GAC units, groundwater normally enters the top of the unit and flows down through the column. As the groundwater flows down through the unit, contaminants are adsorbed onto the surface of the carbon particles. The size of the GAC units is established based on groundwater flow rate, contact time between the groundwater and GAC, and contaminant mass loading.

Typical unit hydraulic flow rates to prevent excess pressure drop across the units are 4 to 8 gallons per minute per square foot of GAC unit (gpm/sf). Because of potentially higher future flows, the GAC units for the GM-38 area are sized at a nominal unit hydraulic flow rate of 3.5 gpm/sf. Using standard unit sizes, four 10-foot diameter GAC units would be required. These units could operate at a maximum hydraulic rate of approximately 3,000 gpm.

For effective treatment of groundwater, a minimum nominal contact time of approximately 7.5 to 15 minutes (empty bed basis) is required. The standard 10-foot diameter GAC unit contains 20,000 pounds of GAC and a bed volume of approximately 5800 gallons. With four units operating at the anticipated flow rate of 1,100 gpm, the GAC system will provide a nominal contract time of 21 minutes. At the hydraulic limit of 3,000 gpm, the GAC system would provide a nominal contract time of 7.5 minutes.

Under normal operating conditions, the GAC adsorption units will allow the groundwater to pass through the units without any detectable change in quality. In the event that an upset occurs in the air stripping portion of the treatment train, the GAC units will adsorb residual contaminants prior to discharge. Based on the minimal anticipated contaminant loading (7 pound of GAC per day), the GAC adsorption units should not require replacement through out the life of the project. However, GAC adsorption units act as filtration unit and are subject to both particulate and biological fouling. As a result, partial GAC change out through surface skimming and/or full GAC change out may be required periodically (e.g. 20,000 pounds per year).

4.1.4 Filtration

Filtration will use two parallel bag filtration units to remove suspended solids from the groundwater prior to re-injection. The unit consists of filter bags that are removed from the units and then either cleaned and placed back into the unit or disposed directly.

Bag filtration units are applicable to waters streams with very low concentrations of suspended solids [less than 1 milligram per liter (mg/l)]. Based on the existing data, suspended solids are not expected to be a concern over the long term. However, some suspended solids may periodically be present in the groundwater from trace metals in the groundwater that precipitate under aerated conditions (e.g. iron), the periodic breakthrough of natural sediments during normal pump starting conditions, and flakes of debris from pump and piping materials.

In addition to the planned long term operation with minimal operation and maintenance, these bag filters can also be used during the initial start up of the system to help treat recovery well and injection well development water.

4.1.5 Treated Groundwater Re-Injection

Treated groundwater will be conveyed to approximately four Re-Injection Wells (IW-1 to IW-4) located near boring VPB-47 to re-introduce the groundwater into the aquifer. Each Re-Injection Well will extend to a depth of approximately 150 feet bgs and create a localized groundwater mound of up to 20 feet above the current groundwater table. The minimum depth of the mounded groundwater will be 25 feet bgs.

The final number of re-injection wells cannot be determined until the GM-38 Area Groundwater Remediation System is operating. Theoretically, only two re-injection wells are required, with each well capable of handling the total anticipated system flow rate of 1,100 gpm. In practice, the number of re-injection wells required is higher. Air entrainment in the aquifer and particulate buildup can impact the effectiveness of each re-injection well.

4.2 SYSTEMS DESCRIPTION AND OPERATION

The purpose of this section is to describe the equipment of each of the above listed systems and the way in which they are intended to be operated and controlled. Refer to the process equipment list provided in Section 4.3 and to the Piping and Instrumentation Diagram (Drawings P-2 and P-3) for an illustration of the process equipment and controls. Alarm conditions will be defined during subsequent design steps, and as such are not shown on Drawings P-2 and P-3, or discussed in this section.

4.2.1 Groundwater Extraction

The groundwater extraction system includes two Recovery Wells (RW-1, RW-2), the two associated Groundwater Extraction Pumps (P-1, P-2), and control instrumentation. Each wellhead is installed inside an underground vault located of in the middle of a street (South Herman for RW-1, North Windhorst for RW-2) accessible through a cover flush with the pavement. The vault is a 6-foot diameter manhole and approximately 7 feet deep, with an open bottom. A disconnect switch will also be located within this manhole with a local pole mounted control switch use to deactivate the power prior to entry into the manhole. Based on property access issues, New York State Department of Transportation property located approximately 140 east of RW-1 may also be a viable option for installation of RW-1.

The two Groundwater Extraction Pumps (P-1, P-2) are of the submersible electrically driven type. Pump P-1, installed in RW-1, has a normal capacity of 800 gpm and pump P-2 installed in RW-2 has a normal capacity of 300 gpm. By adjusting groundwater flow control valve positions, the selected pumps have the capacity to increase groundwater extraction rates by approximately 50% for a total system flow rate of 1,800 gpm. Extracted groundwater is conveyed to the treatment building by buried individual transfer lines that merge into a common header inside the treatment building. Motor starters will also be located within the treatment building.

The groundwater level in each Recovery Well and operation of each Groundwater Extraction Pump are controlled by individual level control systems. Each system consists of a well-mounted level-measuring element (LE-1, LE-2), a level transmitter (LT-1, LT-2) located inside the wellhead vault, and a panel-mounted "ON OFF AUTO" hand switch (HS-P1, HS-P2) and level controller (LC-1, LC-2) with associated "LO" level switches (LSL-1, LSL-2) located inside the treatment building. Operation of the Groundwater Extraction Pumps is normally continuous. With the hand switches in the "AUTO" position, which is the normal mode, the pumps are automatically stopped by the "LO" level switches in the wells (LSL-1, LSL-2), "LO" flow switches on the discharge lines (FSL-1, FSL-2), the "HI" level switch in the Air Stripping Column (LSH-3), and "HI" or "LO" pH switches in the pH Control System (ASL-1, ASH-1). Operation of the Groundwater Extraction Pumps is interlocked to that of the Air Stripper Blower and the Re-Injection Pump.

The discharge flow of each Groundwater Extraction Pump is measured by individual flow control systems. Each flow control system consists of an in-line flow-measuring element (FE-1, FE-2), a flow transmitter (FT-1, FT-2), a manual flow control valve (FV-1, FV-2), a flow controller (FC-1, FC-2) with associated "LO" flow switches (FSL-1, FSL-2), and flow indicator-totalizer (FIQ-1, FIQ-2). The flow control systems are located inside the treatment building.

4.2.2 Air Stripping and Offgas Treatment

The air stripping and offgas treatment systems are located inside the treatment building, except for the top portion of the Air Stripping Column that extends above the building roof. These systems include an Air Stripping Column (AS-1), a Re-Injection Pump (P-3), an Air Stripper Blower (B-1), an Offgas Heater System (HX-1), an Offgas Blower (B-2), a Vapor-Phase GAC Adsorption System (GAC-5, GAC-6), and a Sodium Hydroxide Feed System (CFS-1). The systems also include the associated instrumentation and controls.

Prior to air stripping, the pH of the extracted groundwater, typically equal to approximately 5.5 S.U. or less, will be adjusted to 6.5 to 8.5 to achieve anticipated discharge criteria and to reduce its corrosiveness. This is done by injecting approximately 1.1 gallons per day (gpd) of a 50-percent caustic solution in the influent pipe to the Air Stripping Column. The Sodium Hydroxide Feed System consist of a 55-gallon drum which is the commercial container in which this chemical is purchased and a diaphragm-type chemical feed pump with a manually adjustable capacity of 1 to 10 gallons per day (gpd). Operation of the chemical feed pump is controlled by a panel-mounted "ON-OFF-AUTO" switch. (HS-CFS1). Operation of this pump is interlocked with the operation of the Extraction Pumps (P-1, P-2)

The extracted groundwater is discharged under pressure to the top of the Air Stripping Column and is distributed evenly over the entire section of that column by a manifold. The groundwater then percolates downward through a 25 foot bed of 2- to 3 inch diameter plastic elements (Jaeger Tripack or equivalent). As the groundwater flows downward through the packing medium, it meets an upward current of air provided by the 7,350 cfm Air Stripper Blower. The countercurrent flow of air removes the volatile organic compounds, goes through a demister to minimize entrainment of water droplets in the offgas, and exits from the top of the column, while the treated groundwater is collected in a sump at the bottom of the column. The Air Stripping Column is a vertical, cylindrical unit, 10 feet in diameter and approximately 47 feet high.

The groundwater collected at the bottom of the Air Stripping Column is conveyed to the Groundwater GAC Adsorption System, Bag Filter System, and then to the re-injection wells by a 1,200 gpm horizontal centrifugal Re-Injection Pump. Water level in the Air Stripping Column sump and operation of the Re-Injection Pump are controlled by a level control system. This system consists of a sump-mounted level-measuring element (LE-3), and in-line level control valve (LCV-3), a local level transmitter (LT-3), and a panel-mounted "ON OFF AUTO" hand switch (HS-P3) and level controller (LC-3) with associated "HI" and "LO" level switches (LSH-3/LSL-3). Operation of the Re-Injection Pump is normally continuous. With the hand switch in the "AUTO" position, which is the normal mode, the pump is automatically started and stopped by the "HI" and "LO" switches as triggered by the level controller. To prevent overly frequent cycling of the Re-Injection Pump, the discharge flow of that pump will be regulated by the level control valve (LCV-3), as modulated by the level controller (LC-3) to maintain the liquid level in the Air Stripping Column sump as constant as possible. Under normal operating conditions, a 4-inch line will be used recycle approximately 100 gpm of water to the Air Stripper Column groundwater inlet header. The recycle line stabilizes the effects of the flow control valve, especially under reduced flow rates through the system. The recycle line also simplifies start-up operations and provides a means of circulating fluids during periodic column media cleaning. Operation of the Re-Injection Pump is interlocked to that of the Air Stripper Blower and Groundwater Extraction Pumps and to the groundwater level in the Re-Injection

Wells. During startup, column cleaning activities, and reduced flow from the extraction system, a recycle line on the pump discharge is used to direct flow to the Air Stripping Column water inlet.

Operation of the Air Stripper Blower is controlled by a pressure control system. The system consists of an in-line measuring element (PE-1), a local transmitter (PT-1), a panel-mounted controller (PC-1) with associated "HI" (PSH-1) and "LO" (PSL-1) switches, and a common a panel-mounted "ON-OFF-AUTO" hand switch (HS-B1). Operation of the Air Stripper Blower is normally continuous. With this hand switch in the "AUTO" position, which is the normal mode, the blower is automatically stopped by the "HI" or "LO" pressure switch. An in-line low flow switch (FSL-1) will also be installed in the discharge of the Air Stripper Blower to automatically stop the Air Stripper in case of insufficient air flow to the Air Stripping Column. Operation of the Air Stripper Blower is interlocked to that of the Re-Injection Pump and Groundwater Extraction Pumps.

The temperature of the exhaust air from the Air Stripping Column is controlled by the in-line 75 kW electric Offgas Heater to reduce humidity that would decrease the efficiency of the Vapor-Phase GAC Adsorption System. Temperature of the Offgas Heater is controlled by a temperature control system. This system consists of an in-line temperature-measuring element (TE-1), a local temperature transmitter (TT-1), and a panel-mounted "ON OFF AUTO" hand switch (HS-HX1) and temperature indicator-controller (TCS-1) with associated "HI" and "LO" temperature switches (TSH-1/TSL-1). With the hand switch in the "AUTO" position, which is the normal mode, temperature inside the heater is thermostatically controlled by the "HI" and "LO" temperature switches as triggered by the temperature indicator-controller.

The Vapor-Phase GAC Adsorption System is sized to capture the VOCs removed from the groundwater in the Air Stripping Column and consists of one adsorption unit with a GAC capacity of 13,600 pounds. It is anticipated that this unit will have to be replaced every 6 to 9 months. Treated clean air is then discharged to the atmosphere through an exhaust stack.

A second 13,600 pound Vapor-Phase GAC Adsorber will be provided as a contingency measure to address potentially higher than expected concentrations of VOCs in the groundwater. The second adsorber will operate in series with the first Vapor-Phase GAC Adsorber. The second unit will initially operate during the startup of the system and may be used periodically during the long term operation of the system to address peak loadings of VOCs.

Because of the increased pressure drop associated with the second Vapor-Phase GAC Adsorber, an auxiliary in-line Offgas Blower is required. This blower will be sized the same as the Air Stripper Blower. Operation of the Offgas Blower will be continuous when the second Vapor-Phase GAC Adsorber is on line and can be operated without the second Vapor-Phase GAC Adsorber on line to increase the air flow rate through the Air Stripper Column and thereby improve the VOC removal efficiency of the column. The Vapor Phase Blower will be controlled with a panel-mounted "ON-OFF-AUTO" hand switch (HS-B2). The Vapor Phase Blower will normally operate in the "AUTO" position and be interlocked to the Air Stripper Blower.

4.2.3 Granular Activated Carbon Polishing

Four 20,000-pound liquid phase GAC units will be used to provide a polishing step for the groundwater exiting the Air Stripping Column. Under normal conditions, the Groundwater GAC Adsorption System will operate as flow through units, without affecting the quality of the treated groundwater. Since the GM-38 Area Groundwater Remediation System will normally operate without continuous operator attention, the liquid phase GAC units are used to treat the groundwater during periods in which higher than anticipated concentrations of VOCs enter the Recovery Wells and are not sufficiently removed in the Air Stripper Column, or for short periods of time when an upset condition occurs within the Air Stripper Column, (e.g. blower failure).

The Groundwater GAC Adsorption System will normally operate without a separate control system. Pressure gauges located on the influent and effluent of the liquid phase GAC units will be used to monitor the pressure drop across the units and the associated buildup of solids within the units. In the event that excessive pressure drop across the liquid phase GAC units occurs unexpectedly, then groundwater will accumulate in the Air Stripper Column and trigger the high level alarm (LSH-3).

Based on the anticipated contaminant loading to the Groundwater GAC Adsorption System, the GAC should not have to be replaced for the duration of the project. However, liquid phase GAC units act as filters for particulates and provide a medium for biological growth. Based on the characteristics of the groundwater, particulates and biological growth are not expected to be significant in the short run, but may become a problem over a period of months to years. As such, based on pressure drop, partial or complete change out of GAC in the units is anticipated.

4.2.4 Bag Filter System

The Bag Filter System consists of two pressure units operating in parallel (BF-1, BF-2), each with eight 15-micron disposable bags. Each unit is sized to handle the entire 1,100 gpm system flow rate, but under normal operation, both units will operate, with each receiving approximately half that flow rate. The filter bags will be changed periodically based on either schedule or pressure drop across the units. During change out, flow through the treatment system will continue, while one unit at a time is isolated from the flow system, depressurized, and opened, and the bags changed.

There are no automatic controls associated with the Bag Filter System. In the event that excessive pressure drop across the filter unit occurs, flow to the Re-injection Wells will drop resulting in a backup through the treatment system which will eventually shutdown automatically based on a the high level switch (LSH-3) in the Air Stripping Column sump.

4.2.5 Treated Groundwater Re-Injection

The treated groundwater re-injection system consists of two to four Re-Injection Wells (IW-1 to IW-4) located near boring VPB-47. The system also includes associated instruments and controls that are either field-mounted or panel-mounted in the treatment building. Each re-injection wellhead and associated field instruments and controls are installed in underground vaults similar to those provided for the Recovery Wells.

The treated groundwater flow to each Re-Injection Well is measured by individual flow indication system at the wells. This system consists of an in-line flow-measuring elements (FE-3 to FE-6), local flow indicator-transmitter (FIT-3 to FIT-6), and a panel-mounted flow indicator-totalizers (FIQ-3 to FIQ-6). The local flow indicators is used with local flow control valves to balance water distribution between the Re-Injection Wells.

The groundwater level in each Re-Injection Well is monitored by individual level control systems. Each level control system consists of a well-mounted level-measuring element (LE-4 to LE-7), a level transmitter (LT-4 to LT-7) also located inside the wellhead vault, and a panel-mounted level indicator-controller (LIC-4 to LIC-7) and associated “HI” level switches (LSH-4 to LSH-7) located inside the treatment building. Flow of treated groundwater to the Re-Injection Wells is normally continuous. If the groundwater level in any of these wells, as measured and indicated by the level control system, exceeds a pre-set elevation, the “HI” level switch is triggered by the level indicator-controller and this automatically stops the Re-Injection Pump.

4.2.6 Auxiliary Equipment

Treatment building drainage from minor spillage will be collected in a sump and recycled from there to the Air Stripping Column by a 10 gpm centrifugal submersible-type Building Sump Pump (P-4). Liquid level in the treatment building sump and operation of the Building Sump Pump are controlled by a level control system. This system consists of a sump-mounted level-measuring element (LE-8), a local level transmitter (LT-8), and a panel mounted “ON OFF AUTO” hand switch (HS-P4) and level controller (LC-8) with associated “HI” and “LO” level switches (LSH-8/LSL-8). With the hand switch in the "AUTO" position, which is the normal mode, the Building Sump Pump is automatically started and stopped by the "HI" and "LO" level switches as triggered by the level controller. A Sump Bag Filtration System (SBF-1, SBF-2) located on the Building Sump Pump discharge will be used to prevent general building particulates from the building from entering the groundwater treatment train.

4.2.7 Monitoring

Monitoring associated with the GM-38 Remedy will consist of the following elements.

- Groundwater quality testing (VOCs) and water level measurements from a network of monitoring wells.

- Water quality testing (VOCs) from Recovery Wells, Air Stripper Column effluent, and Groundwater GAC Adsorption System effluent.

- Air quality testing (VOCs) from Vapor Phase GAC Adsorption System influent, effluent, and intermediate (if present).

Groundwater samples will be collected from approximately from 26 monitoring wells (24 new and 2 existing monitoring wells) and analyzed for VOCs to monitor remediation of the aquifer. Samples will be collected quarterly for the first year, and then annually thereafter. This data will be used to better define the extent of the GM-38 Area hot spot contamination. Monitoring wells that have concentrations of VOCs in groundwater consistently less than 100 µg/l and with a decreasing trend in concentration can be removed from the monitoring program.

Groundwater level measurements will be collected from approximately 26 monitoring wells (24 new and 2 existing monitoring wells) to evaluate the capture zone for the GM-38 Remedy. Capture zone analysis, in combination with groundwater quality data, will be used to evaluate the effectiveness of the recovery well extraction rates and the need for modification to extraction rates and/or additional recovery wells. Measurements will be conducted quarterly for the first year, and then annually thereafter.

Water samples will be collected in the GM-38 Area groundwater treatment system to evaluate the effectiveness of critical treatment components. In particular, the effectiveness of the air stripper column will be monitored closely. Water samples will be collected from the two recovery wells to represent the influent to the Air Stripper Column, and from the Air Stripper Column effluent. Also, based on anticipated discharge permit requirements, the effluent from the Groundwater GAC Adsorption System will be sampled. The samples will be analyzed for VOCs. The frequency of monitoring will be determined during the discharge permit process, but is currently anticipated to be monthly.

Air samples will be collected to evaluate the effectiveness of the Vapor Phase GAC treatment units and to determine the change out schedule for the GAC. During initial operation, a two stage GAC unit is anticipated. Samples will be collected from the Vapor Phase GAC Adsorption System influent, effluent, and between the GAC units (intermediate) and analyzed for VOCs. During long-term operation, only a single stage GAC unit is anticipated. At that time, the intermediate sample will not be collected. The frequency of monitoring will be determined during the discharge permit process, but is currently anticipated to be monthly.

4.3 TREATMENT BUILDING SERVICE REQUIREMENTS

The following services will be required at the groundwater treatment building:

- Access road and parking area
- Outdoor lighting
- Telephone system
- Indoor lighting
- Heating, ventilation, and air conditioning
- Fire protection system
- Security and alarm system
- Electrical Supply
- Fencing
- Sewage

The following services will not be required at the groundwater treatment building:

- Office space
- Potable Water
- Natural gas

5.0 EQUIPMENT ANALYSIS

The purpose of the process equipment list shown below is to provide a functional description of the process equipment components for of the groundwater extraction and treatment systems. Items within that list are grouped by type of equipment (e.g., pumps, blowers, VOC removal equipment, instruments, etc.). Catalog cuts for typical equipment are presented in Appendix D. Generic components such as valves, electrical starters etc. are not listed here but will be shown on the drawings and described in the technical specifications.

Pumps

Item Number	Number Required	NAME/DESCRIPTION
P-1	1	<u>Groundwater Extraction Pump</u> Type: submersible centrifugal Capacity: 800 gpm @ 150 ft TDH Motor: 50 HP
P-2	1	<u>Groundwater Extraction Pump</u> Type: submersible centrifugal Capacity: 300 gpm @ 150 ft TDH Motor: 25 HP
P-3	1	<u>Re-Injection Pump</u> Type: horizontal, centrifugal Capacity: 1,200 gpm @ 60 ft TDH Motor: 30 HP
P-4	1	<u>Building Sump Pump</u> Type: submersible centrifugal Capacity: 10 gpm @ 50 ft TDH Motor: 0.5 HP

Blowers

Item Number	Number Required	NAME/DESCRIPTION
B-1	1	<u>Air Stripper Blower</u> Type: centrifugal, V-belt driven Capacity: 7,350 cfm @ 0.6 psig Motor: 30 HP
B-2	1	<u>Offgas Blower</u> Type: centrifugal, V-belt driven Capacity: 7,350 cfm @ 0.6 psig Motor: 30 HP

VOC Removal Equipment

Item Number	Number Required	NAME/DESCRIPTION
AS-1	1 (existing)	Air Stripping Column Type: vertical, cylindrical Construction: aluminum Packing: 25-foot Jaeger Tripack. Dimensions: 10.0 ft Dia x 47 ft H
GAC-1 GAC-2 GAC-3 GAC-4	4	Groundwater GAC Adsorption System GAC Capacity: 20,000 pounds per unit Construction: carbon steel Dimensions: 10.0 ft Dia x 18 H
HX-1	1	Offgas Heater Type: in-line, electric Power: 75 kW
GAC-5 GAC-6	2	Vapor-Phase GAC Adsorption System GAC capacity: 13,600 pounds per unit Construction: polypropylene Dimensions: 16.5 x 8.0 x 7.5 ft LWH per unit

Solids Removal Equipment

Item Number	Number Required	NAME/DESCRIPTION
BF-1 BF-2	2	Bag Filters Type: Pressurized housing with eight (8) bag filter elements Configuration: Vertical, cylindrical, leg-mounted, side inlet, bottom outlet Filter Bag: Disposable, pleated, 15-micron pore size Normal Operating Flow: 1,100 gpm Dimensions: 31.5" diameter x 80" height
SBF-1 SBF-2	2	Bag Filters Type: Pressurized housing with one (1) bag filter element Configuration: Inline Filter Bag: Disposable, pleated, 15-micron pore size Anticipated Operating Flow: 10 gpm

Chemical Feed Systems

Item Number	Number Required	NAME/DESCRIPTION
CFS-1	1	Sodium Hydroxide Feed System System to include: • 55-gallon drum (commercial container for 50% NaOH solution) • Diaphragm-type, manually-adjustable 1-10 gpd feed pump

Instrumentation and Controls

Item Number	Number Required	NAME/DESCRIPTION
LCS-1 LCS-2	2 lots	Recovery Well Level Control Systems Each system includes: • well-mounted measuring element (LE-1, LE-2) • local transmitter (LT-1, LT-2) and controller (LC-1, LC-2) • local LO switches (LSL-1 and LSL-2)
LCS-3	1 lot	Air Stripping Column Sump Level Control System System includes: • sump-mounted measuring element (LE-3) • in-line automatic control valve (FV-3) • panel-mounted indicator/transmitter (LIT-3) and controller (LC-3) • panel-mounted hi and lo switches (LSH-3/LSL-3)
LCS-4 to LCS-7	4 lots	Re-Injection Wells Level Control Systems Each system includes: • well-mounted measuring element (LE-3) • local transmitter (LT-4 to LT-7) and indicator/controller (LIC-4 to LIC-7) • local hi switches (LSH-4 TO LSH-7)
LCS-8	1 lot	Building Sump Level Control System System includes: • sump-mounted measuring element (LE-8) • local (LT-8) • panel-mounted controller (LC-8) • panel-mounted hi and lo switches (LSH-8/LSL-8)
FCS-1 FCS-2	2 lots	Recovery Well Flow Control Systems Each system includes: • in-line measuring element (FE-1, FE-2) • local transmitter (FT-1, FT-2) • manual control valve (FV-1, FV-2) • panel-mounted LO switches (FSL-1, FSL-2) • panel-mounted indicator/totalizer (FIQ-1, FIQ-2)
FCS-3 to FCS-6	4 lots	Re-Injection Well Flow Control Systems Each system includes: • in-line measuring element (FE-3 to FE-6) • local indicating transmitter (FIT-3 to FIT-6) • manual control valve (FV-3 to FV-6) • panel-mounted indicator/totalizer (FIQ-3 to FIQ-6)
FSL-3	1	Air Stripper Blower Low Flow Switch in-line (FSL-3)

Item Number	Number Required	NAME/DESCRIPTION
PCS-1	1 lot	Air Stripper Blower Pressure System System includes: • in-line measuring element (PE-1) • local transmitter (PT-1) • panel-mounted controller (PC-1) • panel-mounted HI and LO switches (PSH-1/PSL-1)
TCS-1	1 lot	Offgas Heater Temperature Control System System includes: • in-line measuring element (TE-1) • local transmitter (TT-1) • panel-mounted indicator/controller (TC-1) • panel-mounted HI and LO switches (TSH-1/TSL-1)
ACS-1	1 lot	pH Control system System includes: • in-line measuring element (AE-1) • local transmitter (AT-1) • panel-mounted indicating controller (AIC-1) • panel-mounted HI and LO switches (ASH-1/AHSL-1)
CP-1	1 Lot	Control Panel Wall-mounted NEMA 12 enclosure with face-mounted instruments and access door. Face-mounted instrument include: • Flow indicator-totalizers for P-1 (FIQ-1), P-2 (FIQ-2) • Flow indicator-totalizers for IW-1 (FIQ-3), IW-2 (FIQ-4), IW-3 (FIQ-5), and IW-4 (FIQ-6) • Level indicator for Air Stripping Column sump (LIC-3) • Temperature indicator-controller for HX-1 (TIC-1) • ON-OFF-AUTO switches for P-1, P-2, P-3, P-4, B-1, B-2, HX-1, and CFS-1 chemical feed pump • Running lights for electric motors • pH indicator-controller for AIC-1 • Alarms

Notes:

cfm	Cubic Feet per minute
Dia	Diameter
gpd	Gallons per day
gpm	Gallons per minute
H	Height
HP	Horsepower
kW	Kilowatt
LWH	Length x width x height
NaOH	Sodium hydroxide/caustic SODA
psig	Pound per square inch gauge
TDH	Total displacement head

6.0 SCHEDULE

The project schedule is presented in Figure 6-1. Primary milestones for this schedule include: complete remedial design in June 2003, construction from June to December 2003, and start up from January to March 2004.

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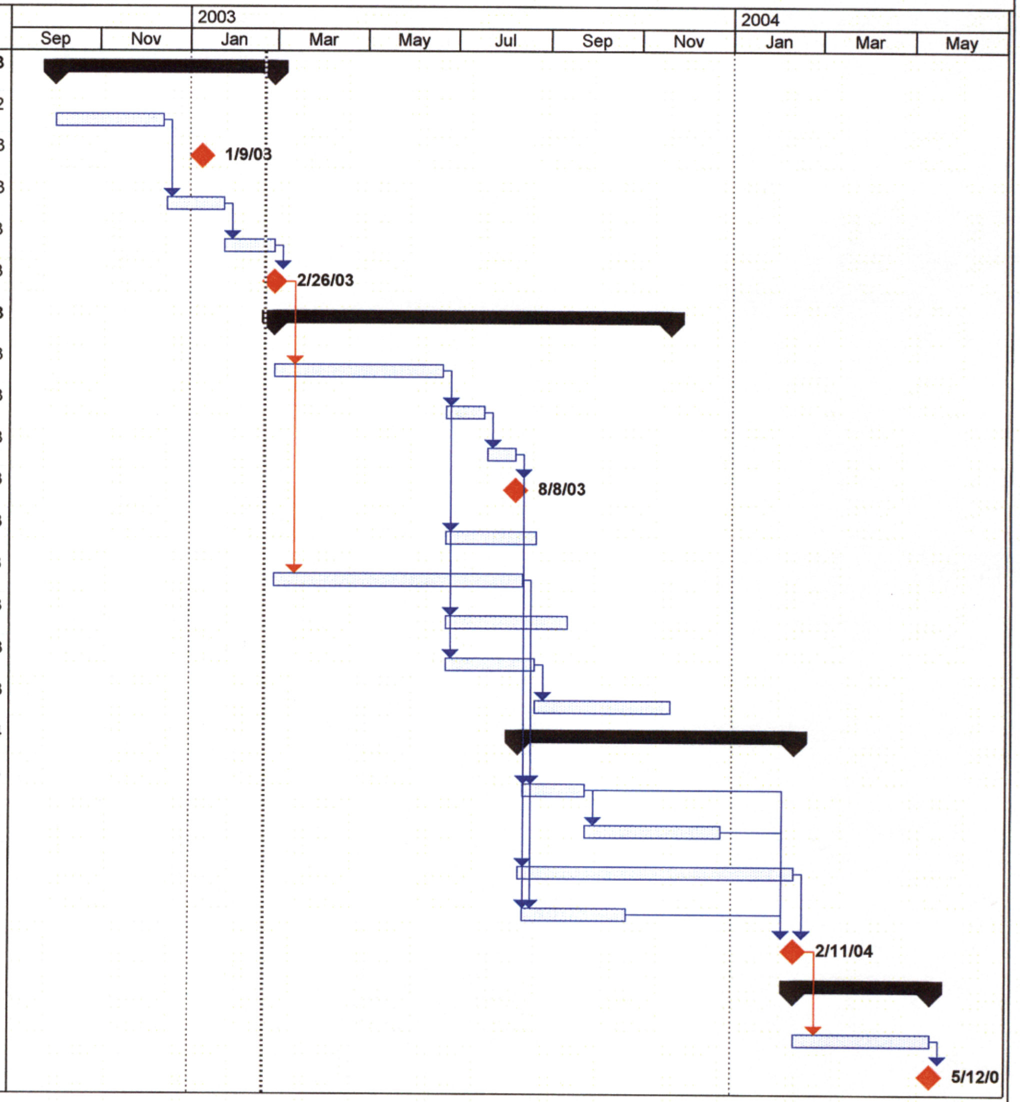
FIGURE 6-1

ENGINEERING AND CONSTRUCTION SCHEDULE
OFF-SITE GM 38 AREA REMEDY
NWIRP BETHPAGE - NEW YORK

ID	Task Name	Duration	Start	Finish
1	**Preliminary Engineering**	**106 days**	**Wed 10/2/02**	**Wed 2/26/03**
2	Preliminary Analysis Report - Draft	53 days	Wed 10/2/02	Fri 12/13/02
3	Review Meeting	0 days	Thu 1/9/03	Thu 1/9/03
4	Report Review	29 days	Mon 12/16/02	Thu 1/23/03
5	Basis of Design Report Final	24 days	Fri 1/24/03	Wed 2/26/03
6	Submit Final BODR	0 days	Wed 2/26/03	Wed 2/26/03
7	**Detailed Design**	**191 days**	**Thu 2/27/03**	**Thu 11/20/03**
8	Implementation Plan - Draft	82 days	Thu 2/27/03	Fri 6/20/03
9	Regulatory Review	20 days	Mon 6/23/03	Fri 7/18/03
10	Implemenation Plan - Final	15 days	Mon 7/21/03	Fri 8/8/03
11	Submit Final Plan	0 days	Fri 8/8/03	Fri 8/8/03
12	Surveying	45 days	Mon 6/23/03	Fri 8/22/03
13	Site Access Negotiations	120 days	Thu 2/27/03	Wed 8/13/03
14	Permitting	60 days	Mon 6/23/03	Fri 9/12/03
15	Prepare Equipment Specifications	44 days	Mon 6/23/03	Thu 8/21/03
16	Equipment Procurement	65 days	Fri 8/22/03	Thu 11/20/03
17	**Construction**	**133 days**	**Mon 8/11/03**	**Wed 2/11/04**
18	Re-Injection Wells Installation	30 days	Thu 8/14/03	Wed 9/24/03
19	Recovery Wells Installation	65 days	Thu 9/25/03	Wed 12/24/03
20	Groundwater Treatment System Construction	133 days	Mon 8/11/03	Wed 2/11/04
21	Transfer Pipellines Installation	50 days	Thu 8/14/03	Wed 10/22/03
22	Construction Complete	0 days	Wed 2/11/04	Wed 2/11/04
23	**System Startup**	**65 days**	**Thu 2/12/04**	**Wed 5/12/04**
24	System Startup	65 days	Thu 2/12/04	Wed 5/12/04
25	Start of Operation	0 days	Wed 5/12/04	Wed 5/12/04



Date: Thu 20/20/03

Task | Progress | Milestone | Summary

CTO 0812

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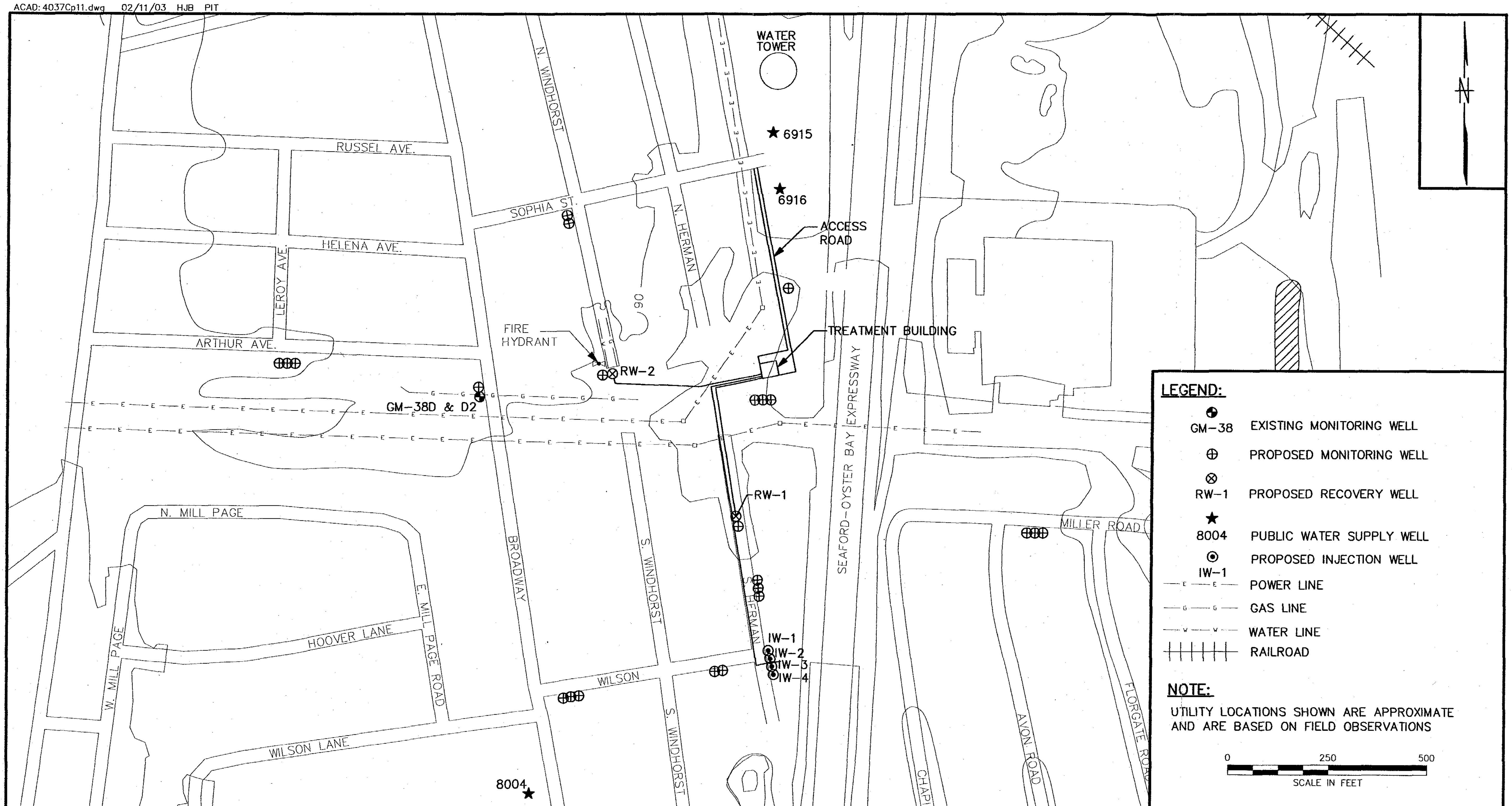

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 11/20/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SITE LAYOUT
GM-38 AREA GROUNDWATER REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037
OWNER NO. ——
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. DRAWING C-1
REV. 0

FORM CADD NO. T+NUS_BH.DGN - REV 0 - 1/20/98

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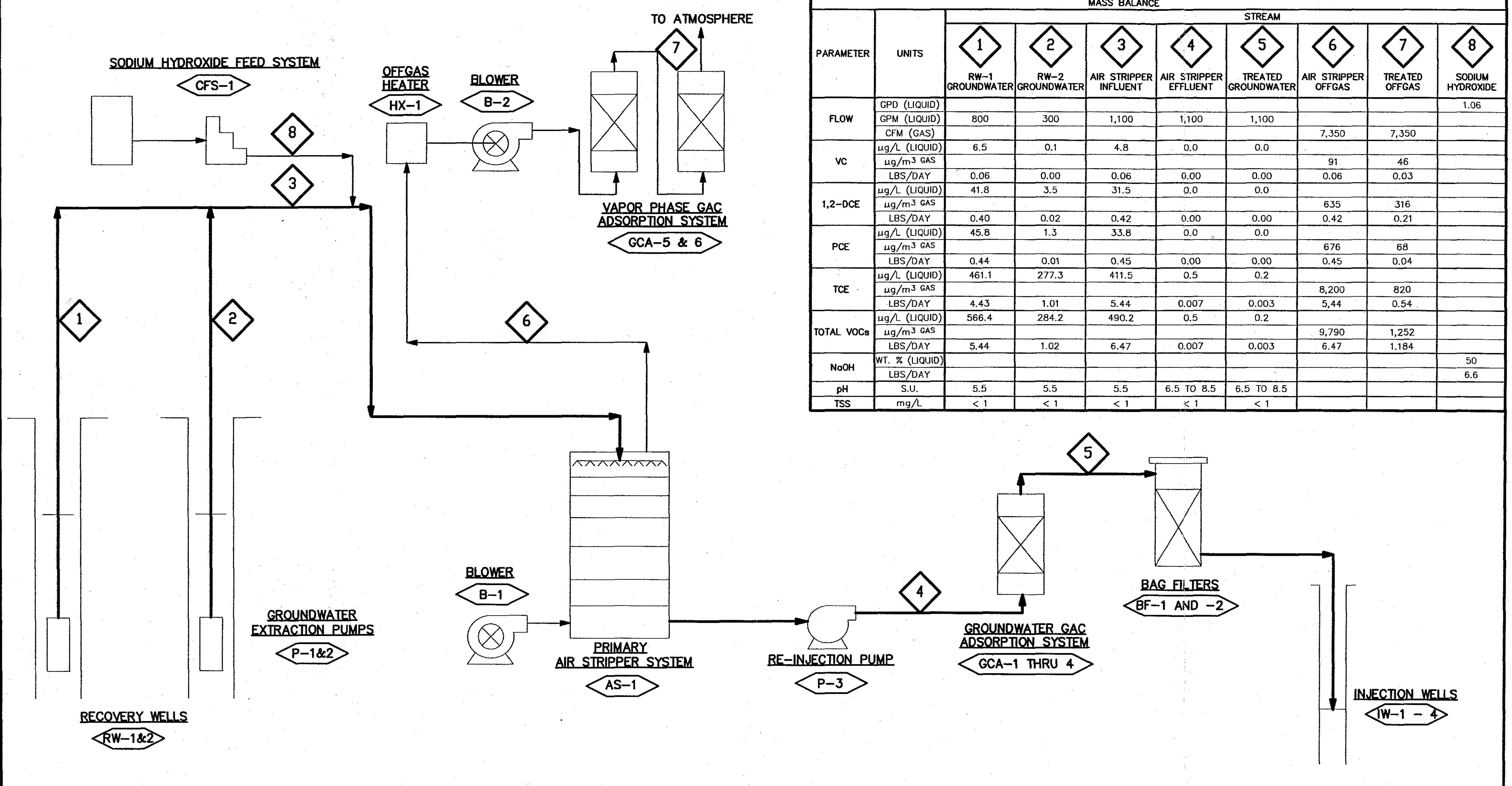

MASS BALANCE

PARAMETER	UNITS	STREAM 1 RW-1 GROUNDWATER	2 RW-2 GROUNDWATER	3 AIR STRIPPER INFLUENT	4 AIR STRIPPER EFFLUENT	5 TREATED GROUNDWATER	6 AIR STRIPPER OFFGAS	7 TREATED OFFGAS	8 SODIUM HYDROXIDE
FLOW	GPD (LIQUID)								1.06
	GPM (LIQUID)	800	300	1,100	1,100	1,100			
	CFM (GAS)						7,350	7,350	
VC	μg/L (LIQUID)	6.5	0.1	4.8	0.0	0.0			
	μg/m3 GAS						91	46	
	LBS/DAY	0.06	0.00	0.06	0.00	0.00	0.06	0.03	
1,2-DCE	μg/L (LIQUID)	41.8	3.5	31.5	0.0	0.0			
	μg/m3 GAS						635	316	
	LBS/DAY	0.40	0.02	0.42	0.00	0.00	0.42	0.21	
PCE	μg/L (LIQUID)	45.8	1.3	33.8	0.0	0.0			
	μg/m3 GAS						676	68	
	LBS/DAY	0.44	0.01	0.45	0.00	0.00	0.45	0.04	
TCE	μg/L (LIQUID)	461.1	277.3	411.5	0.5	0.2			
	μg/m3 GAS						8,200	820	
	LBS/DAY	4.43	1.01	5.44	0.007	0.003	5,44	0.54	
TOTAL VOCs	μg/L (LIQUID)	566.4	284.2	490.2	0.5	0.2			
	μg/m3 GAS						9,790	1,252	
	LBS/DAY	5.44	1.02	6.47	0.007	0.003	6.47	1.184	
NaOH	WT. % (LIQUID)								50
	LBS/DAY								6.6
pH	S.U.	5.5	5.5	5.5	6.5 TO 8.5	6.5 TO 8.5			
TSS	mg/L	< 1	< 1	< 1	< 1	< 1			

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 11/20/02
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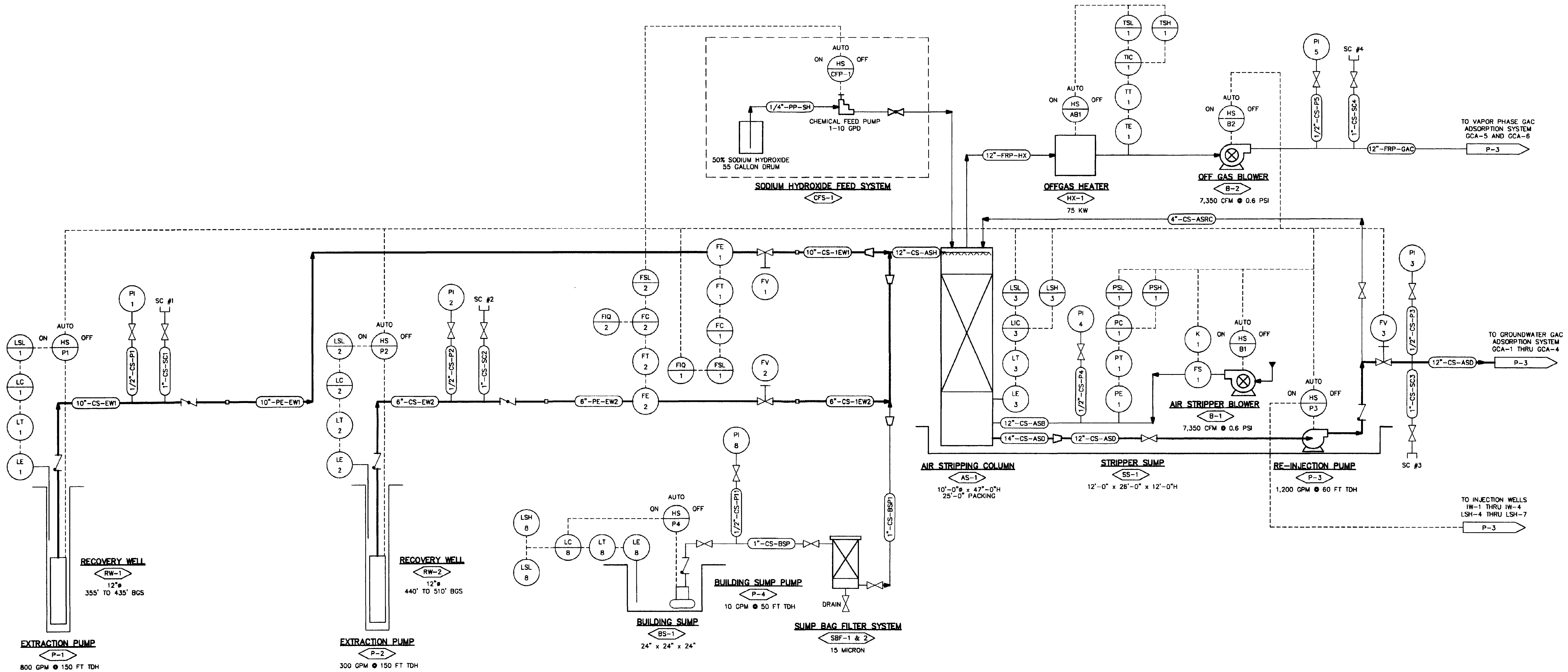
COST/SCHED-AREA
SCALE NOT TO SCALE

Tetra Tech NUS, Inc.

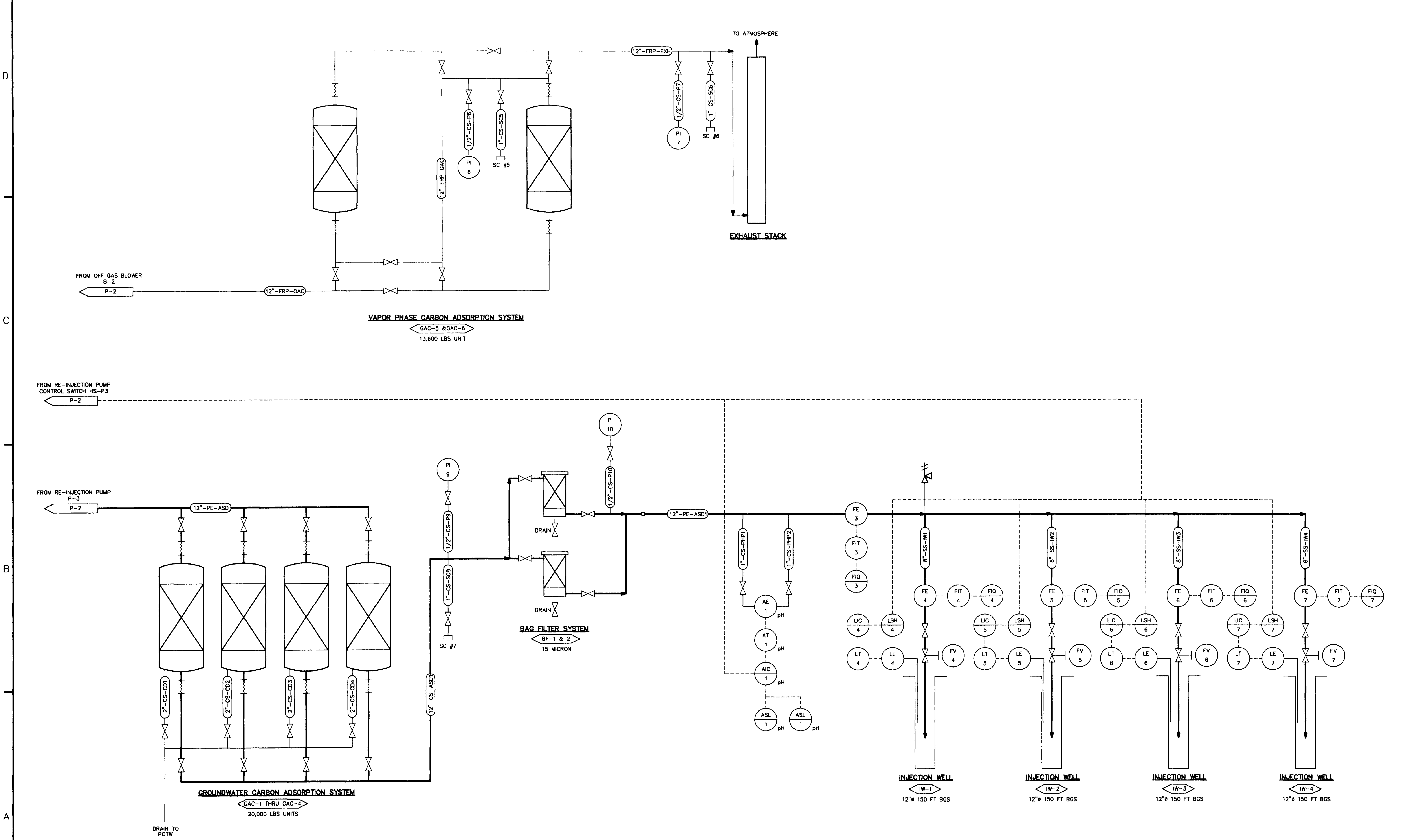
PROCESS FLOW DIAGRAM
AIR STRIPPING TREATMENT
OFF-SITE GM-38 AREA REMEDY
NWIRP BETHPAGE
BETHPAGE, NEW YORK

CONTRACT NO. N4037
OWNER NO. 0812
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. DRAWING P-1
REV. 0

FORM CADD NO. TtNUS_BH.DGN - REV 0 - 1/20/98



DRAWN BY MF	DATE 11/06/02	PIPING AND INSTRUMENTATION DIAGRAM GM-38 AREA GROUNDWATER REMEDY NAVAL WEAPONS INDUSTRIAL RESERVE PLANT BETHPAGE, NEW YORK	CONTRACT NO. 4037	
CHECKED BY	DATE		OWNER NO.	
REVISED BY	DATE		APPROVED BY	DATE
SCALE NOT TO SCALE			DRAWING NO. P-2	REV. 0



DRAWN BY MF	DATE 2/13/03	
CHECKED BY	DATE	
REVISED BY	DATE	
SCALE NOT TO SCALE		

PIPING AND INSTRUMENTATION DIAGRAM
GM-38 AREA
GROUNDWATER REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037
OWNER NO.
APPROVED BY DATE
DRAWING NO. P-3 REV. 0

ACAD: 4037PD07.dwg 02/26/03 MF PIT

APPENDIX A

TVOC PLUME CALCULATIONS

MAC 11-1-02

MAXIMUM TOTAL VOC CONCENTRATION ISOCONTOUR CALCULATIONS
OFFSITE GM-38 AREA0 REMEDY
NWIRP BETHPAGE, NY

Vertical Profile Boring	Maximum Total VOC Concentration (mg/L)	Feet Below Ground Surface
VPB-38	3420	250
VPB-40	327	280
VPB-42	21	200
VPB-47	945	400
VPB-48	104	200
VPB-51	3144	240
VPB-77	125	250

Data used to place isoconcentration contour lines on Figure.
Approach uses logrithamic average of data points.

Measured Distances		
From	To	Distance (ft)
VPB-38	VPB-40	1300
VPB-38	VPB-42	2040
VPB-38	VPB-47	1085
VPB-38	VPB-48	910
VPB-38	VPB-51	830
VPB-40	VPB-47	1295
VPB-40	VPB-48	1290
VPB-40	VPB-51	1840
VPB-40	VPB-77	2360
VPB-42	VPB-47	2055
VPB-42	VPB-48	2870
VPB-42	VPB-51	1310
VPB-42	VPB-77	2740
VPB-47	VPB-48	1840
VPB-47	VPB-51	890
VPB-47	VPB-77	1445
VPB-48	VPB-51	1735
VPB-51	VPB-77	2110

A-1

MAXIMUM TOTAL VOC CONCENTRATION ISOCONTOUR CALCULATIONS
OFFSITE GM-38 AREA0 REMEDY
NWIRP BETHPAGE, NY

0018

Isocontour calculation

From	To	LOG (From)	LOG (To)	Number of Contour Intervals Between Points	Distance between contours (ft)	Distance to the closest contour from point in "From" column (ft)	Distance to the closest contour from point in "To" column (ft)	Distance to the 500 contour from the 1000 contour (ft)	Distance to the second contour from the closest contour (ft)
				[LOG(From)-LOG(To)]	[Distance/(LOG(From)-LOG(To))]	[(LOG(From)-3, 2 or 1) *Distance between	[(LOG(To)-3 or 2) *Distance between intervals]	[(1-(LOG(500)-2))*Distance between intervals]	Distance between contours.
VPB-38	VPB-40	3.534	2.515	1.019	1275	681		384	
VPB-38	VPB-42	3.534	1.322	2.212	922	493		278	922
VPB-38	VPB-47	3.534	2.975	0.559	1942	1037		585	
VPB-38	VPB-48	3.534	2.017	1.517	600	320		181	
VPB-38	VPB-51	3.534	3.497	0.037	22713				
VPB-40	VPB-47	2.515	2.975	0.461	2810	1446		846	
VPB-40	VPB-48	2.515	2.017	0.498	2593				
VPB-40	VPB-51	2.515	3.497	0.983	1872	963		564	
VPB-40	VPB-77	2.515	2.097	0.418	5651				
VPB-42	VPB-47	1.322	2.975	1.653	1243	401		374	1243
VPB-42	VPB-48	1.322	2.017	0.695	4131		70		
VPB-42	VPB-51	1.322	3.497	2.175	602	194		181	602
VPB-42	VPB-77	1.322	2.097	0.775	3537		343		
VPB-47	VPB-48	2.975	2.017	0.958	1920		33	578	1920
VPB-47	VPB-51	2.975	3.497	0.522	1705		848	513	
VPB-47	VPB-77	2.975	2.097	0.879	1645		159	495	
VPB-48	VPB-51	2.017	3.497	1.480	1172		583	353	
VPB-51	VPB-77	3.497	2.097	1.401	1507		146	454	

A-2

NIC

MAXIMUM COMPUTUER MODEL LAYER TVOC CONCENTRATION BY LAYER ISOCONTOUR CALCULATIONS
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Vertical Profile Boring	Maximum Average Layer Total VOC Concentration (mg/L)
VPB-38	1672
VPB-47	392
VPB-48	66
VPB-51	1056

This calculation sheet is used to establish the boundaries associated with maximum computer model layer TVOC concentrations. Because average concentrations across each model layer are used, these concentrations will be less than individual sample maximums.

Measured Distances		
From	To	Distance (ft)
VPB-38	VPB-47	1085
VPB-38	VPB-48	910
VPB-38	VPB-51	830
VPB-47	VPB-51	890

Isocontour calculation

A-3

From	To	LOG (From)	LOG (To)	Number of Contour Intervals Between Points	Distance between contours (ft)	Distance to the closest contour from point in "From" column (ft)	Distance to the closest contour from point in "To" column (ft)	Distance to the 500 contour from the 1000 contour (ft)	Distance to the second contour from the closest contour (ft)
				[LOG(From)-LOG(To)]	[Distance/(LOG(From)-LOG(To))]	[(LOG(From)-3, 2 or 1) *Distance between intervals]	[(LOG(To)-3 or 2) *Distance between intervals]	[(1-(LOG(500)-2))*Distance between intervals]	Distance between contours.
VPB-38	VPB-47	3.223	2.593	0.630	1722	384		518	
VPB-38	VPB-48	3.223	1.820	1.404	648	145		195	648
VPB-38	VPB-51	3.223	3.024	0.200	4159				
VPB-47	VPB-51	2.593	3.024	0.430	2068		49	623	

DNB

VPB-38 AVERAGE PEAK LAYER CONCENTRATION
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-38 (330 ft West) Total VOCs (µg/L)	Model Layer	Average (mg/L)
45	50	21	Layer 1 50 to 0 feet msl	24.0
	50	27		
25	70	NA		
5	90	NA		
-5	100	37	Layer 2 0 to -50 feet msl	37.0
-15	110	NA		
-35	130	NA		
-55	150	4	Layer 3 -50 to -100 feet msl	4.0
-75	170	NA		
-95	190	NA		
-105	200	NA	Layer 4 -100 to -175 feet msl	1671.6
-115	210	NA		
-125	220	0		
-135	230	NA		
-145	240	169		
-155	250	3420		
-165	260	2337		
-175	270	2432		
-185	280	2231	Layer 5 -175 to -250 feet msl	942.3
-195	290	1130		
-205	300	620		
-215	310	289		
-225	320	591		
-235	330	1006		
-245	340	729		
-255	350	1308	Layer 6 -250 to -340 feet msl	593.6
-265	360	NA		
-275	370	NA		
-285	380	507		
-295	390	556		
-305	400	586		
-315	410	NA		
-325	420	NA		
-335	430	1		
-345	440	NA	Layer 7 -340 to -435 feet msl	348.5
-355	450	875		
-365	460	566		
-375	470	526		
-385	480	NA		
-395	490	122		
-405	500	NA		
-415	510	2		
-425	520	NA		
-435	530	0		
-445	540	12	Layer 8 -435 to -515 feet msl	5.3
-455	550	NA		
-465	560	0		
-475	570	4		
-485	580	NA		
-495	590	NA		
-505	600	NA		
-515	610	NA		
-520	615	NA	Layer 9 -515 to -570 feet msl	1.0
-525	620	1		
-535	630	NA		
-545	640	NA		
-555	650	NA		
-565	660	NA		
-575	670	0	Layer 10 570 to -620 feet msl	0.0
-585	680	NA		
-595	690	NA		
-605	700	NA		
-615	710	NA		
-625	720	NA	Layer 11 -620 to -735 feet msl	NA
-635	730	NA		
-645	740	NA		
-655	750	NA		
-665	760	NA		
-675	770	NA		
-685	780	NA		
-695	790	NA		
-705	800	NA		

Note: *Ground surface elevation assumed to be constant as 95' above mean sea level.*
NA = Not Analyzed
Denotes concentration greater than 500 µg/L.
Denotes maximum average layer concentration.

NWC

VPB-47 AVERAGE PEAK LAYER CONCENTRATION
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-47 (400 ft South) Total VOCs (µg/L)	Model Layer	Average (mg/L)
45	50	8	Layer 1 50 to 0 feet msl	8.0
25	70	NA		
5	90	NA		
-5	100	NA	Layer 2 0 to -50 feet msl	0.0
-15	110	NA		
-25	120	NA		
-35	130	0		
-55	150	1	Layer 3 -50 to -100 feet msl	1.0
-75	170	NA		
-95	190	NA		
-105	200	NA	Layer 4 -100 to -175 feet msl	58.5
-115	210	0		
-125	220	12		
-135	230	NA		
-145	240	40		
-155	250	NA		
-165	260	182		
-175	270	NA		
-185	280	181	Layer 5 -175 to -250 feet msl	[illegible]
-195	290	NA		
-205	300	280		
-215	310	NA		
-225	320	NA		
-235	330	NA		
-245	340	716		
-255	350	NA	Layer 6 -250 to -340 feet msl	383.3
-260	355	NA		
-265	360	NA		
-275	370	NA		
-285	380	185		
-295	390	NA		
-305	400	945		
-315	410	NA		
-325	420	20		
-335	430	NA		
-340	435	NA		
-345	440	NA	Layer 7 -340 to -435 feet msl	59.0
-355	450	NA		
-365	460	NA		
-375	470	NA		
-385	480	118		
-395	490	NA		
-405	500	NA		
-415	510	NA		
-425	520	NA		
-435	530	0		
-445	540	10	Layer 8 -435 to -515 feet msl	5.0
-455	550	NA		
-465	560	10		
-470	565	NA		
-475	570	NA		
-485	580	NA		
-490	585	NA		
-495	590	0		
-505	600	0		
-515	610	NA		
-525	620	0	Layer 9 -515 to -570 feet msl	0.0
-535	630	NA		
-545	640	NA		
-555	650	NA		
-565	660	NA		
-575	670	2	Layer 10 -570 to -620 feet msl	1.7
-585	680	2		
-595	690	NA		
-605	700	1		
-615	710	NA		
-625	720	0	Layer 11 -620 to -735 feet msl	189.0
-635	730	NA		
-645	740	378		
-655	750	NA		
-665	760	NA		
-675	770	NA		
-685	780	NA		
-695	790	NA		
-705	800	NA		

Note: Ground surface elevation assumed to be
NA = Not Analyzed
Denotes concentration greater than 500 µg/L.
Denotes maximum average layer concentration.

VPB-48 AVERAGE PEAK LAYER CONCENTRATION
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-48 Total VOCs (µg/L)	Model Layer	Average (µg/L)
45	50	NA	Layer 1 50 to 0 feet msl	NA
25	70	NA		
5	90	NA		
-5	100	0	Layer 2 0 to -50 feet msl	0
-15	110	NA		
-35	130	NA		
-55	150	0	Layer 3 -50 to -100 feet msl	0
-75	170	NA		
-95	190	NA		
-105	200	104	Layer 4 -100 to -175 feet msl	[illegible]
-115	210	NA		
-125	220	56		
-135	230	NA		
-145	240	3		
-155	250	NA		
-165	260	102		
-175	270	NA		
-185	280	33	Layer 5 -175 to -250 feet msl	22.75
-195	290	NA		
-205	300	34		
-215	310	NA		
-225	320	4		
-235	330	NA		
-245	340	20		
-255	350	NA	Layer 6 -250 to -340 feet msl	21
-265	360	30		
-275	370	NA		
-285	380	3		
-295	390	NA		
-305	400	51		
-315	410	NA		
-325	420	0		
-335	430	NA		
-345	440	0	Layer 7 -340 to -435 feet msl	0
-355	450	NA		
-375	470	NA		
-385	480	0		
-395	490	NA		
-405	500	0		
-415	510	NA		
-425	520	0		
-435	530	NA		
-445	540	0	Layer 8 -435 to -515 feet msl	0
-455	550	NA		
-465	560	0		
-475	570	NA		
-485	580	0		
-495	590	NA		
-505	600	0		
-515	610	NA		
-525	620	0	Layer 9 -515 to -570 feet msl	0
-535	630	NA		
-545	640	0		
-555	650	NA		
-565	660	0		
-575	670	NA	Layer 10 -570 to -620 feet msl	0
-585	680	0		
-595	690	NA		
-605	700	0		
-615	710	NA		
-625	720	0	Layer 11 -620 to -735 feet msl	0
-635	730	NA		
-645	740	0		
-655	750	NA		
-675	770	NA		
-695	790	NA		
-705	800	NA		

Note: Ground surface elevation assumed to be constant as 95' above mean sea level.
NA = Not Analyzed
Denotes concentration greater than 500 µg/L.
Denotes maximum average layer concentration.

DJC

VPB-51 AVERAGE PEAK LAYER CONCENTRATION
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-51 (410 ft East) Total VOCs (µg/L)	Model Layer	Model Layer
45	50	NA	Layer 1 50 to 0 feet msl	2.0
	50	2		
25	70	NA		
5	90	NA		
-5	100	2	Layer 2 0 to -50 feet msl	2.0
-15	110	NA		
-35	130	NA		
-55	150	2	Layer 3 -50 to -100 feet msl	2.0
-75	170	NA		
-95	190	NA		
-105	200	173	Layer 4 -100 to -175 feet msl	
-115	210	NA		
-125	220	881		
-135	230	NA		
-145	240	3144		
-155	250	NA		
-165	260	24		
-175	270	NA		
-185	280	4	Layer 5 -175 to -250 feet msl	165.3
-195	290	NA		
-205	300	381		
-215	310	NA		
-225	320	242		
-235	330	NA		
-245	340	34		
-255	350	NA	Layer 6 -250 to -340 feet msl	6.3
-265	360	7		
-275	370	NA		
-285	380	6		
-295	390	NA		
-305	400	11		
-315	410	NA		
-325	420	1		
-335	430	NA		
-345	440	3	Layer 7 -340 to -435 feet msl	18.0
-355	450	NA		
-365	460	49		
-375	470	NA		
-385	480	0		
-395	490	NA		
-400	495	NA		
-405	500	NA		
-415	510	38		
-425	520	0		
-435	530	NA		
-445	540	29	Layer 8 -435 to -515 feet msl	15.3
-455	550	NA		
-465	560	17		
-470	565	NA		
-475	570	NA		
-485	580	12		
-495	590	NA		
-505	600	3		
-515	610	NA		
-520	615	0	Layer 9 -515 to -570 feet msl	0.0
-525	620	NA		
-535	630	NA		
-545	640	0		
-555	650	NA		
-565	660	NA		
-575	670	NA	Layer 10 -570 to -620 feet msl	2.0
-585	680	NA		
-595	690	NA		
-605	700	2		
-615	710	NA		
-625	720	3	Layer 11 -620 to -735 feet msl	1.5
-635	730	NA		
-645	740	NA		
-655	750	NA		
-665	760	NA		
-675	770	NA		
-685	780	0		
-695	790	NA		
-705	800	NA		

Note: Ground surface elevation assumed to be constant as 95' above mean sea level.
NA = Not Analyzed
Denotes concentration greater than 500 µg/L.
Denotes maximum average layer concentration.

Tetra Tech NUS		*STANDARD CALCULATION SHEET*	
CLIENT: USN NorthDiv CLEAN	FILE No: 4037/1400	BY: DDB	PAGE: 1 of 2
SUBJECT: Area, Volume, and Mass Calculations Off-Site GM-38 Remedy, NWIRP Bethpage, New York		CHECKED BY: J.P.K	DATE: 11/1/2002

1.0 GM-38 Area Calculations

The estimated area of contamination was determined by measuring the area enclosed by the TVOC contours presented on Figure 2-2 of the report, see attached markup.
The area enclosed by these contours are as follows.

Model Layer - 1000 ug/l:	11	acres	
	479,160	square feet	
Model Layer - 500 ug/l:	29	acres	(includes model layer 1000 ug/l area)
	1,263,240	square feet	
Individual Sample - 500 ug/l	67	acres	(includes model layer 500 ug/l area)
	2,918,520	square feet	

Individual sample contours are based on the maximum sample in a VPB. Computer model layers used the same data based, but represent averages over an interval of approximately 70 to 100 feet.

2.0 GM-38 Area Volume Calculations

The estimated volume of contaminated groundwater in each contoured zone is based on the area (above) and the estimated thickness of contamination. The thickness of contamination is estimated as follows.

Model Layer 1000 ug/l: use an average thickness of groundwater > 1000 ug/l in VPB-38 and VPB-51.

VPB-38	250 to 350 feet bgs	100 feet
VPB-51	230 to 250	20
	Mean	60 feet

Model Layer 500 ug/l: use an average thickness of groundwater > 500 ug/l in VPB-38, VPB-47, and VPB-51.

VPB-38	250 to 480 feet bgs	230 feet
VPB-47	340 to 410	70
VPB-51	210 to 250	40
	Mean	113 feet

For individual sample > 500 ug/l: use the average thickness of VPB-47 (inner edge) and 0 feet outer edge.

35 feet

Note that this thickness applies to the area outside of model layer - 500 ug/l

	Area acres	Thickness feet	Volume gallon	
Model Layer - 1000 ug/l	11	60	64,514,102	Calculation assumes a porosity of 30%.
Model Layer (ML) - 500 ug/l	29	113	321,267,197	(Total volume including ML 1000 ug/l)
Incremental ML - 500 ug/l	18	-	256,753,094	Incremental volume of ML 500 ug/l
Individual Sample - 500 ug/l	38	35	130,005,691	Consists of fringe around ML 500 ug/l
Total			451,272,888	

Tetra Tech NUS		STANDARD CALCULATION SHEET	
CLIENT: USN NorthDiv CLEAN	FILE No: 4037/1400	BY: DDB	PAGE: 2 of 2
SUBJECT: Area, Volume, and Mass Calculations Off-Site GM-38 Remedy, NWIRP Bethpage, New York		CHECKED BY: J.P.K.	DATE: 11/1/2002

3.0 GM-38 Area Mass calculations

To calculate the mass of TVOCs present in the aquifer, asign an average TVOC to each area volume.
The average TVOC concentration within each area volume will be calculated with the geometric mean of the maximum and minimum.

	TVOC Min (ug/l)	TVOC Max (ug/l)	TVOC Average (ug/l)	Pounds TVOC	
Model Layer - 1000 ug/l	1000	3420	1849	995	(based on volume x conc)
Incremental ML - 500 ug/l	500	1000	707	1,514	
Individual Sample - 500 ug/l	500	1000	707	767	
		Total Soluble Mass		3,276	
			Say	3,300	pounds

Calculate the mass associated with TVOC adsorbed onto soil particles.
Since the majority of the TVOC is TCE, use the Koc for TCE = 128

Total organic carbon concentrations were measured for several samples of the sandy aquifer. These values were less than 0.1%
Therefore use 0.1%, which is the minimum value intended for use in this formula.

fraction organic carbon (foc) = 0.001

The distribution coefficient (Kd) equals Koc times foc = 0.128

The mass of contaminant on soil can be calculated by using the ratio of the mass of soil to mass of water and concentration in soil to water

Mass ratio Soil/water = 0.7 *2.6 (density of soil)/0.3*1.0 Calculation assumes 30% porosity.

Mass ratio equals 6.067

Concentration ratio = Kd 0.128

Mass of contaminant ratio = mass ratio x concentration ratio = 0.78

Mass of insoluble contaminant then equals 2,544 pounds

Say 2,500 pounds

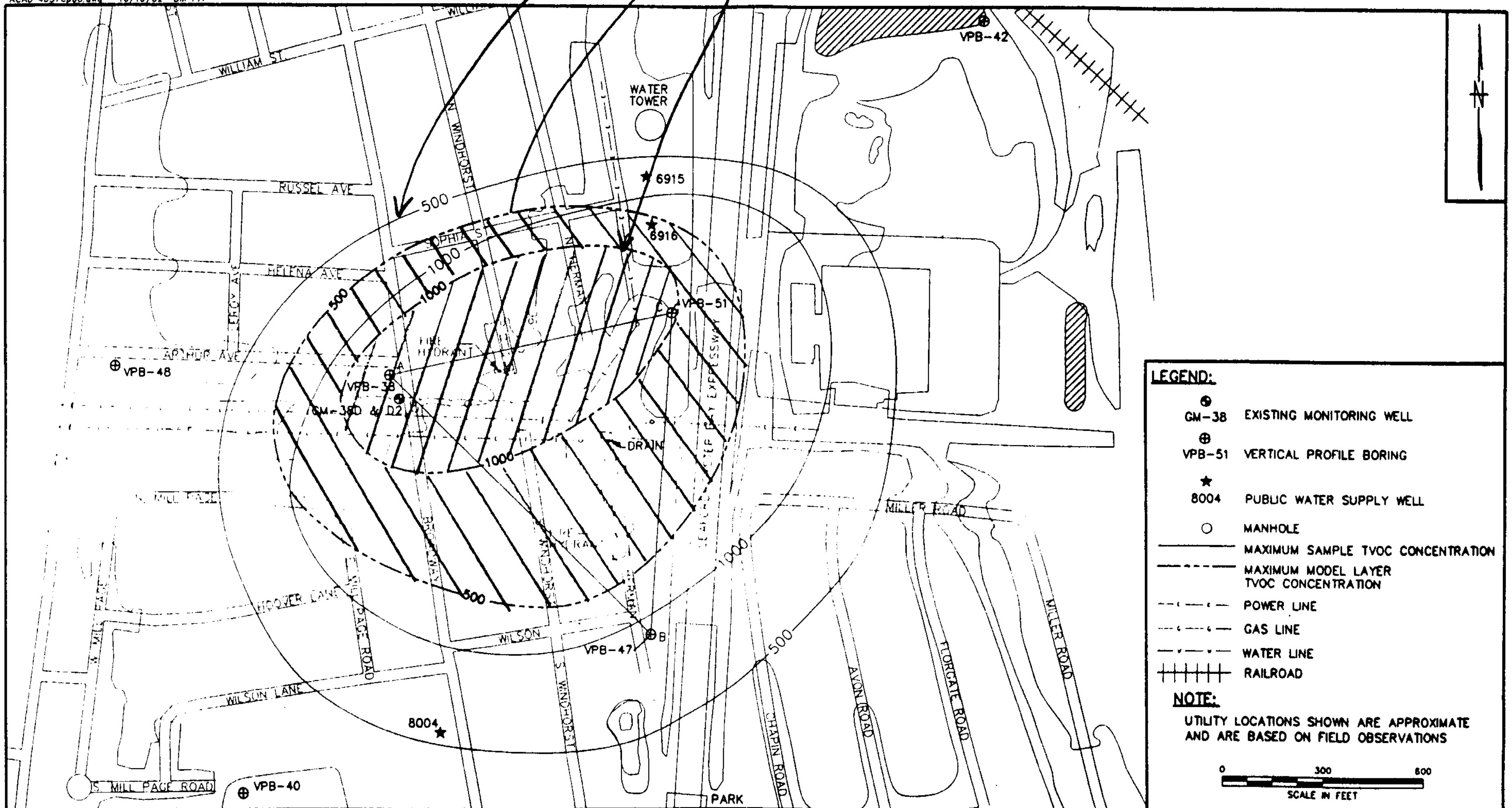
Total mass then equals soluble plus insoluble, which equals 5,800 pounds

1" = 470 feet

500 : 13.33, 26.43/2 = 13.21 SI = 2,918,000 SF = 67 acres
500 : 5.46, 11.47/2 = 5.74 SI = 1,268,000 SF = 29 acres
1000 : 2.108, 4.27/2 = 2.13 SI = 471,000 SF = 11 acres

A-10

ACAD 4037Cp08.dwg 10/16/02 DM PIT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DM DATE 10/16/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

MAXIMUM TOTAL VOLATILE ORGANIC COMPOUND CONCENTRTIONS
OFFSITE GM-38 AREA REMEDY
NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
BETHPAGE, NEW YORK

CONTRACT NO. 4037
OWNER NO.
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2-2 REV. 0

FORM CADD NO. TNUS_BH.DGN - REV 0 - 1/20/98

STL Pittsburgh

Tt TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE 1 OF 1

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
N4037	NWIRP BETHPAGE	D. BRAYACK 412 921 8375	STL PITT / VERONICA B.

SAMPLERS (SIGNATURE): S J Conti

FIELD OPERATIONS LEADER AND PHONE NUMBER: S CONTI 412 921 8422

ADDRESS: 450 WILLIAM PITT WAY

CARRIER/WAYBILL NUMBER: FED EX # 8316 7332 9467

CITY, STATE: PITTSBURGH, PA 15238

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

GM38D
GM38D 2

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	VOAS 40ml Vials (G; 4°C HCL)	SVOCS 1L Amber (G; 4°C)	TCL PEST/PCB 1L Amber (G; 4°C)	HERBICIDES 1L Amber (G; 4°C)	TAL METALS - HARDNESS (CALC) 500ml PE (P; 4°C HNO3)	CYANIDE (TOT) 250ml P (P; 4°C NaOH)	SULFIDES (TOT) 250ml	TOC (40ml VIAL) (G; 4°C H2SO4)	COD (250ml) (P; 4°C H2SO4)	BOD (1L) (P; 4°C)	TDS, TSS, ALK. (500ml) (P; 4°C)	COMMENTS
9/19	0700	BP-TB-091902	AQ	G	2	2											
9/19	1230	BP-GM38D2-0902	GW	G	15	2	2	1	1	1	1	1	3	1	1	1	
9/19	1530	BP-GM38D-0902	GW	G	15	2	2	1	1	1	1	1	3	1	1	1	
																	1 - TEMP BLANK ALSO

1. RELINQUISHED BY S J Conti	DATE 9/19/02	TIME 1730	1. RECEIVED BY FED EX	DATE	TIME
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY Patrick R [illegible]	DATE 9/20/02	TIME 0945
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS: PURGED BY ARCADIS G&M

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY) 3/99

FORM NO. TINUS-001

A-11

ARCADIS GERAGHTY & MILLER

Water Sampling Log

Project	TTNUS (Grumman)	Project No.	NY001369.0001.00002	Page	1 of 1
Site Location	BETHAGE, NY			Date	9/19/02
Site/Well No.	GM-38D2	Replicate No.		Code No.	
Weather	Sunny, 80°	Sampling Time:	Begin 0945	End	1250

Evacuation Data	
Measuring Point	TOC
MP Elevation (ft)	
Land Surface Elevation (ft)	
Sounded Well Depth (ft bmp)	495'
Depth to ~~Water (ft bmp)~~ PACKER	472'
Water-Level Elevation (ft)	
Water Column in Well (ft)	23
Casing Diameter/Type	4" (.65)
Gallons in Well	14.95
Gallons Pumped/Bailed Prior to Sampling	45
~~Sample Pump Intake~~ PACKER Setting ~~(ft bmp)~~ (PIZ)	220
Purge Time	begin 0945 end 1250
Pumping Rate (gpm)	
Evacuation Method	Dedicated Bladder Pump

Field Parameters	I	1V	2V	3V
Color	Colorless			
Odor	odorless			
Appearance	Clear			
pH (s.u.)	4.99	5.21	5.18	5.16
Conductivity (mS/cm)	.083	.064	.066	.06
~~(umhos/cm)~~ (mV) eh/ORP	312	421	427	427
Turbidity (NTU)	2.0	1.9	1.4	1.7
Temperature (°C)	16.0	15.1	14.9	14.
Dissolved Oxygen (mg/L)	3.92	4.06	4.08	4.0
Salinity (%)				
DTW ~~Sampling Method~~	48.81'	48.84'	48.85'	48

Remarks

Initial DTW: 48.81'

1V = 15 gallons (3 BUCKETS)

BUCKETS ~~||||~~ ||||

Constituents Sampled	Container Description	Number	Preservative
* NONE by ARCADIS			

** VOC, TOC, COD, BOD, TCLP PEST / PCB, TAL METALS, SVOC, Herbicides, TDS, TSS, Alkalinity, Sulfides (total), and Cyanide by TTNUS

Sampling Personnel KS

Well Casing Volumes

Gal./Ft.				
	1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
	1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

bmp	below measuring point	ml	mililiter	NTU	Nephelometric Turbidity Units
°C	Degrees Celsius	mS/cm	Milisiemens per centimeter	PVC	Polyvinyl chloride
ft	feet	msl	mean sea-level	s.u.	Standard units
gpm	Gallons per minute	N/A	Not Applicable	umhos/cm	Micromhos per centimeter
mg/L	Miligrams per liter	NR	Not Recorded	VOC	Volatile Organic Compounds

Wtrsamlg.xls.xls
10/30/98

ARCADIS GERAGHTY & MILLER

Water Sampling Log

Project: TTNUS (GRUMMAN) Project No. NY00/369.0001.00002 Page 1 of 1

Site Location: Bethpage, NY Date: 9/19/02

Site/Well No.: GM-38D Replicate No.: Code No.:

Weather: Sunny, 80° Sampling Time: Begin 1305 End 1545

Evacuation Data	
Measuring Point	TOC
MP Elevation (ft)	
Land Surface Elevation (ft)	
Sounded Well Depth (ft bmp)	340'
Depth to ~~Water~~ PACKER (ft bmp)	317'
Water-Level Elevation (ft)	
Water Column in Well (ft)	23'
Casing Diameter/Type	4" (.65)
Gallons in Well	14.95
Gallons Pumped/Bailed Prior to Sampling	45
~~Sample Pump Intake~~ PACKER Setting ~~(ft bmp)~~ (PSI)	145
Purge Time	begin 1305 end 1545
Pumping Rate (gpm)	
Evacuation Method	Dedicated bladder pump

Field Parameters	I	1V	2V	3V
Color	colorless			
Odor	odorless			
Appearance	clear			
pH (s.u.)	4.22	5.50	5.50	5.[illegible]
Conductivity (mS/cm)	.080	.097	.089	.0[illegible]
~~(µmhos/cm)~~ eh/ORP (mV)	496	472	476	4[illegible]
Turbidity (NTU)	7.8	4.7	2.5	1[illegible]
Temperature (°C)	16.0	15.9	15.6	1[illegible]
Dissolved Oxygen (mg/L)	4.92	4.51	4.53	4.[illegible]
Salinity (%)				
DTW ~~Sampling Method~~	45.61'	45.61'	45.61'	4[illegible]
Remarks				

Initial DTW: 45.61'

1V = 3 BUCKETS (15 GALLONS)

BUCKETS : ~~||||~~ ||||

Constituents Sampled	Container Description	Number	Preservative
* NONE by ARCADIS			
** VOC, TOC, COD, BOD, TCLP PEST/PCB, TAL METALS, SVOC, Herbicides, TDS, TSS, Alkalinity, Sulfides (Total) and, cyanide by TTNUS.			

⊕ compression fitting missing on well, decontaminate one from 38D2 before and after replace on 38D2 (NEED A NEW ONE)

Sampling Personnel: KS

Well Casing Volumes

Gal./Ft.	1-¼" = 0.06	2" = 0.16	3" = 0.37	4" = 0.65
	1-½" = 0.09	2-½" = 0.26	3-½" = 0.50	6" = 1.47

bmp	below measuring point	ml	mililiter	NTU	Nephelometric Turbidity Units
°C	Degrees Celsius	mS/cm	Milisiemens per centimeter	PVC	Polyvinyl chloride
ft	feet	msl	mean sea-level	s.u.	Standard units
gpm	Gallons per minute	N/A	Not Applicable	umhos/cm	Micromhos per centimeter
mg/L	Miligrams per liter	NR	Not Recorded	VOC	Volatile Organic Compounds

Wtrsamlg.xls.xls
10/20/98

NYSHO onsite from 1420 – 1425 (Joe L. and one other)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC/MS Volatiles

Lot-Sample #...:	C2I200231-003	**Work Order #...:**	E8KX61AM	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/23/02	**Analysis Date..:**	09/23/02		
Prep Batch #...:	2266428	**Analysis Time..:**	18:50		
Dilution Factor:	15	**Initial Wgt/Vol:**	5 mL	**Final Wgt/Vol..:**	5 mL
Analyst ID.....:	034635	**Instrument ID..:**	HP5		
		Method.........:	SW846 8260B		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	150	ug/L	38
Benzene	**5.4 J**	**15**	**ug/L**	**1.2**
Bromodichloromethane	ND	15	ug/L	2.0
Bromoform	ND	15	ug/L	4.6
Bromomethane	ND	30	ug/L	4.5
2-Butanone	ND	75	ug/L	29
Carbon disulfide	ND	15	ug/L	3.3
Carbon tetrachloride	ND	15	ug/L	4.7
Chlorobenzene	ND	15	ug/L	2.3
Dibromochloromethane	ND	15	ug/L	1.2
Chloroethane	ND	30	ug/L	3.0
Chloroform	ND	15	ug/L	2.6
Chloromethane	ND	30	ug/L	4.2
1,1-Dichloroethane	ND	15	ug/L	3.2
1,2-Dichloroethane	ND	15	ug/L	2.1
1,1-Dichloroethene	ND	15	ug/L	5.7
1,2-Dichloroethene (total)	ND	15	ug/L	9.7
1,2-Dichloropropane	ND	15	ug/L	2.2
cis-1,3-Dichloropropene	ND	15	ug/L	3.3
trans-1,3-Dichloropropene	ND	15	ug/L	1.0
Ethylbenzene	ND	15	ug/L	1.1
2-Hexanone	ND	75	ug/L	25
Methylene chloride	**3.2 J**	**30**	**ug/L**	**2.2**
4-Methyl-2-pentanone	ND	75	ug/L	19
Styrene	ND	15	ug/L	1.0
1,1,2,2-Tetrachloroethane	ND	15	ug/L	4.4
Tetrachloroethene	**9.9 J**	**15**	**ug/L**	**2.9**
Toluene	**7.0 J**	**15**	**ug/L**	**1.9**
1,1,1-Trichloroethane	ND	15	ug/L	4.0
1,1,2-Trichloroethane	ND	15	ug/L	2.0
Trichloroethene	**530**	**15**	**ug/L**	**1.3**
Vinyl chloride	ND	45	ug/L	2.1
Xylenes (total)	ND	45	ug/L	2.1

(Continued on next page)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC/MS Volatiles

Lot-Sample #...:	C2I200231-002	**Work Order #...:**	E8KX21AA	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/23/02	**Analysis Date..:**	09/23/02		
Prep Batch #...:	2266428	**Analysis Time..:**	19:17		
Dilution Factor:	15	**Initial Wgt/Vol:**	5 mL	**Final Wgt/Vol..:**	5 mL
Analyst ID.....:	034635	**Instrument ID..:**	HP5		
		Method.........:	SW846 8260B		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	150	ug/L	38
Benzene	ND	15	ug/L	1.2
Bromodichloromethane	ND	15	ug/L	2.0
Bromoform	ND	15	ug/L	4.6
Bromomethane	ND	30	ug/L	4.5
2-Butanone	ND	75	ug/L	29
Carbon disulfide	ND	15	ug/L	3.3
Carbon tetrachloride	ND	15	ug/L	4.7
Chlorobenzene	ND	15	ug/L	2.3
Dibromochloromethane	ND	15	ug/L	1.2
Chloroethane	ND	30	ug/L	3.0
Chloroform	ND	15	ug/L	2.6
Chloromethane	ND	30	ug/L	4.2
1,1-Dichloroethane	ND	15	ug/L	3.2
1,2-Dichloroethane	ND	15	ug/L	2.1
1,1-Dichloroethene	ND	15	ug/L	5.7
1,2-Dichloroethene (total)	ND	15	ug/L	9.7
1,2-Dichloropropane	ND	15	ug/L	2.2
cis-1,3-Dichloropropene	ND	15	ug/L	3.3
trans-1,3-Dichloropropene	ND	15	ug/L	1.0
Ethylbenzene	ND	15	ug/L	1.1
2-Hexanone	ND	75	ug/L	25
Methylene chloride	**3.7 J**	**30**	**ug/L**	**2.2**
4-Methyl-2-pentanone	ND	75	ug/L	19
Styrene	ND	15	ug/L	1.0
1,1,2,2-Tetrachloroethane	ND	15	ug/L	4.4
Tetrachloroethene	**5.1 J**	**15**	**ug/L**	**2.9**
Toluene	**3.9 J**	**15**	**ug/L**	**1.9**
1,1,1-Trichloroethane	ND	15	ug/L	4.0
1,1,2-Trichloroethane	ND	15	ug/L	2.0
Trichloroethene	**1100 E**	**15**	**ug/L**	**1.3**
Vinyl chloride	ND	45	ug/L	2.1
Xylenes (total)	ND	45	ug/L	2.1

(Continued on next page)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC/MS Volatiles

Lot-Sample #...:	C2I200231-002	**Work Order #...:**	E8KX22AA	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #........:**	
Prep Date......:	09/25/02	**Analysis Date..:**	09/25/02		
Prep Batch #...:	2268363	**Analysis Time..:**	14:28		
Dilution Factor:	40	**Initial Wgt/Vol:**	5 mL	**Final Wgt/Vol..:**	5 mL
Analyst ID.....:	034635	**Instrument ID..:**	HP5		
		Method.........:	SW846 8260B		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	400	ug/L	100
Benzene	ND	40	ug/L	3.3
Bromodichloromethane	ND	40	ug/L	5.4
Bromoform	ND	40	ug/L	12
Bromomethane	ND	80	ug/L	12
2-Butanone	ND	200	ug/L	77
Carbon disulfide	ND	40	ug/L	8.7
Carbon tetrachloride	ND	40	ug/L	12
Chlorobenzene	ND	40	ug/L	6.0
Dibromochloromethane	ND	40	ug/L	3.1
Chloroethane	ND	80	ug/L	7.9
Chloroform	ND	40	ug/L	6.8
Chloromethane	ND	80	ug/L	11
1,1-Dichloroethane	ND	40	ug/L	8.6
1,2-Dichloroethane	ND	40	ug/L	5.6
1,1-Dichloroethene	ND	40	ug/L	15
1,2-Dichloroethene (total)	ND	40	ug/L	26
1,2-Dichloropropane	ND	40	ug/L	5.9
cis-1,3-Dichloropropene	ND	40	ug/L	8.9
trans-1,3-Dichloropropene	ND	40	ug/L	2.8
Ethylbenzene	ND	40	ug/L	2.9
2-Hexanone	ND	200	ug/L	66
Methylene chloride	ND	80	ug/L	5.9
4-Methyl-2-pentanone	ND	200	ug/L	50
Styrene	ND	40	ug/L	2.7
1,1,2,2-Tetrachloroethane	ND	40	ug/L	12
Tetrachloroethene	ND	40	ug/L	7.8
Toluene	ND	40	ug/L	5.0
1,1,1-Trichloroethane	ND	40	ug/L	11
1,1,2-Trichloroethane	ND	40	ug/L	5.3
Trichloroethene	**1100**	**40**	**ug/L**	**3.5**
Vinyl chloride	ND	120	ug/L	5.7
Xylenes (total)	ND	120	ug/L	5.7

(Continued on next page)

TETRA TECH NUS INC

Client Sample ID: BP-TB-091902

GC/MS Volatiles

Lot-Sample #...:	C2I200231-001	**Work Order #...:**	E8KXW1AA	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/25/02	**Analysis Date..:**	09/25/02		
Prep Batch #...:	2268363	**Analysis Time..:**	12:22		
Dilution Factor:	1	**Initial Wgt/Vol:**	5 mL	**Final Wgt/Vol..:**	5 mL
Analyst ID.....:	034635	**Instrument ID..:**	HP5		
		Method.........:	SW846 8260B		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	2.5
Benzene	ND	1.0	ug/L	0.082
Bromodichloromethane	ND	1.0	ug/L	0.13
Bromoform	ND	1.0	ug/L	0.30
Bromomethane	ND	2.0	ug/L	0.30
2-Butanone	ND	5.0	ug/L	1.9
Carbon disulfide	ND	1.0	ug/L	0.22
Carbon tetrachloride	ND	1.0	ug/L	0.31
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.078
Chloroethane	ND	2.0	ug/L	0.20
Chloroform	ND	1.0	ug/L	0.17
Chloromethane	ND	2.0	ug/L	0.28
1,1-Dichloroethane	ND	1.0	ug/L	0.22
1,2-Dichloroethane	ND	1.0	ug/L	0.14
1,1-Dichloroethene	ND	1.0	ug/L	0.38
1,2-Dichloroethene (total)	ND	1.0	ug/L	0.65
1,2-Dichloropropane	ND	1.0	ug/L	0.15
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.22
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.069
Ethylbenzene	ND	1.0	ug/L	0.072
2-Hexanone	ND	5.0	ug/L	1.6
Methylene chloride	ND	2.0	ug/L	0.15
4-Methyl-2-pentanone	ND	5.0	ug/L	1.3
Styrene	ND	1.0	ug/L	0.067
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.29
Tetrachloroethene	ND	1.0	ug/L	0.20
Toluene	ND	1.0	ug/L	0.12
1,1,1-Trichloroethane	ND	1.0	ug/L	0.27
1,1,2-Trichloroethane	ND	1.0	ug/L	0.13
Trichloroethene	ND	1.0	ug/L	0.087
Vinyl chloride	ND	3.0	ug/L	0.14
Xylenes (total)	ND	3.0	ug/L	0.14

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TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC/MS Semivolatiles

Lot-Sample #...:	C2I200231-003	Work Order #...:	E8KX61AV	Matrix.........:	WATER
Date Sampled...:	09/19/02	Date Received..:	09/20/02	MS Run #.......:	
Prep Date......:	09/23/02	Analysis Date..:	10/05/02		
Prep Batch #...:	2266318	Analysis Time..:	17:23		
Dilution Factor:	0.95	Initial Wgt/Vol:	1050 mL	Final Wgt/Vol..:	1 mL
Analyst ID.....:	001562	Instrument ID..:	721		
		Method.........:	SW846 8270C		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	9.5	ug/L	1.5
Acenaphthylene	ND	9.5	ug/L	1.7
Anthracene	ND	9.5	ug/L	1.1
Benzo(a)anthracene	ND	9.5	ug/L	0.89
Benzo(a)pyrene	ND	9.5	ug/L	2.4
Benzo(b)fluoranthene	ND	9.5	ug/L	0.81
Benzo(k)fluoranthene	ND	9.5	ug/L	1.0
Benzo(ghi)perylene	ND	9.5	ug/L	0.95
bis(2-Chloroethoxy) methane	ND	9.5	ug/L	3.3
bis(2-Chloroethyl)-ether	ND	9.5	ug/L	1.4
bis(2-Ethylhexyl) phthalate	10	9.5	ug/L	0.86
4-Bromophenyl phenyl ether	ND	9.5	ug/L	1.2
Butyl benzyl phthalate	ND	9.5	ug/L	0.96
Carbazole	ND	9.5	ug/L	3.0
4-Chloroaniline	ND	9.5	ug/L	3.5
4-Chloro-3-methylphenol	ND	9.5	ug/L	1.2
2-Chloronaphthalene	ND	9.5	ug/L	1.4
2-Chlorophenol	ND	9.5	ug/L	1.3
4-Chlorophenyl phenyl ether	ND	9.5	ug/L	1.5
Chrysene	ND	9.5	ug/L	0.91
Dibenz(a,h)anthracene	ND	9.5	ug/L	0.99
Dibenzofuran	ND	9.5	ug/L	1.4
1,2-Dichlorobenzene	ND	9.5	ug/L	1.3
1,3-Dichlorobenzene	ND	9.5	ug/L	1.2
1,4-Dichlorobenzene	ND	9.5	ug/L	1.3
3,3'-Dichlorobenzidine	ND	48	ug/L	3.7
2,4-Dichlorophenol	ND	9.5	ug/L	1.3
Diethyl phthalate	ND	9.5	ug/L	1.1
2,4-Dimethylphenol	ND	9.5	ug/L	1.7
Dimethyl phthalate	ND	9.5	ug/L	1.2
Di-n-butyl phthalate	ND	9.5	ug/L	1.0
Di-n-octyl phthalate	ND	9.5	ug/L	0.90

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TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC/MS Semivolatiles

Lot-Sample #...: C2I200231-003 Work Order #...: E8KX61AV Matrix.........: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	48	ug/L	1.5
4,6-Dinitro-2-methylphenol	ND	48	ug/L	1.3
2,4-Dinitrotoluene	ND	9.5	ug/L	1.2
2,6-Dinitrotoluene	ND	9.5	ug/L	1.3
Fluoranthene	ND	9.5	ug/L	1.1
Fluorene	ND	9.5	ug/L	1.5
Hexachlorobenzene	ND	9.5	ug/L	1.2
Hexachlorobutadiene	ND	9.5	ug/L	1.4
Hexachlorocyclopenta-diene	ND	48	ug/L	5.9
Hexachloroethane	ND	9.5	ug/L	1.3
Indeno(1,2,3-cd)pyrene	ND	9.5	ug/L	0.95
Isophorone	ND	9.5	ug/L	1.3
2-Methylnaphthalene	ND	9.5	ug/L	1.5
2-Methylphenol	ND	9.5	ug/L	1.5
4-Methylphenol	ND	9.5	ug/L	3.3
Naphthalene	ND	9.5	ug/L	1.4
2-Nitroaniline	ND	48	ug/L	1.0
3-Nitroaniline	ND	48	ug/L	2.6
4-Nitroaniline	ND	48	ug/L	1.1
Nitrobenzene	ND	9.5	ug/L	1.4
2-Nitrophenol	ND	9.5	ug/L	2.8
4-Nitrophenol	ND	48	ug/L	1.7
N-Nitrosodi-n-propyl-amine	ND	9.5	ug/L	1.5
N-Nitrosodiphenylamine	ND	9.5	ug/L	4.0
2,2'-oxybis(1-Chloropropane)	ND	9.5	ug/L	1.6
Pentachlorophenol	ND	48	ug/L	0.78
Phenanthrene	ND	9.5	ug/L	1.0
Phenol	ND	9.5	ug/L	1.9
Pyrene	ND	9.5	ug/L	0.89
1,2,4-Trichloro-benzene	ND	9.5	ug/L	1.3
2,4,5-Trichloro-phenol	ND	9.5	ug/L	1.3
2,4,6-Trichloro-phenol	ND	9.5	ug/L	1.4

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TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC/MS Semivolatiles

Lot-Sample #...: C2I200231-003 **Work Order #...:** E8KX61AV **Matrix.........:** WATER

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	94	(21 - 122)
2-Fluorobiphenyl	80	(30 - 110)
2-Fluorophenol	66	(13 - 110)
Nitrobenzene-d5	77	(32 - 112)
Phenol-d5	74	(10 - 113)
Terphenyl-d14	79	(10 - 144)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC/MS Semivolatiles

Lot-Sample #...:	C2I200231-002	**Work Order #...:**	B8KX21AJ	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/23/02	**Analysis Date..:**	10/05/02		
Prep Batch #...:	2266318	**Analysis Time..:**	16:55		
Dilution Factor:	0.95	**Initial Wgt/Vol:**	1050 mL	**Final Wgt/Vol..:**	1 mL
Analyst ID.....:	001562	**Instrument ID..:**	721		
		Method.........:	SW846 8270C		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Acenaphthene	ND	9.5	ug/L	1.5
Acenaphthylene	ND	9.5	ug/L	1.7
Anthracene	ND	9.5	ug/L	1.1
Benzo(a)anthracene	ND	9.5	ug/L	0.89
Benzo(a)pyrene	ND	9.5	ug/L	2.4
Benzo(b)fluoranthene	ND	9.5	ug/L	0.81
Benzo(k)fluoranthene	ND	9.5	ug/L	1.0
Benzo(ghi)perylene	ND	9.5	ug/L	0.95
bis(2-Chloroethoxy) methane	ND	9.5	ug/L	3.3
bis(2-Chloroethyl)-ether	ND	9.5	ug/L	1.4
bis(2-Ethylhexyl) phthalate	**5.4 J**	**9.5**	**ug/L**	**0.86**
4-Bromophenyl phenyl ether	ND	9.5	ug/L	1.2
Butyl benzyl phthalate	ND	9.5	ug/L	0.96
Carbazole	ND	9.5	ug/L	3.0
4-Chloroaniline	ND	9.5	ug/L	3.5
4-Chloro-3-methylphenol	ND	9.5	ug/L	1.2
2-Chloronaphthalene	ND	9.5	ug/L	1.4
2-Chlorophenol	ND	9.5	ug/L	1.3
4-Chlorophenyl phenyl ether	ND	9.5	ug/L	1.5
Chrysene	ND	9.5	ug/L	0.91
Dibenz(a,h)anthracene	ND	9.5	ug/L	0.99
Dibenzofuran	ND	9.5	ug/L	1.4
1,2-Dichlorobenzene	ND	9.5	ug/L	1.3
1,3-Dichlorobenzene	ND	9.5	ug/L	1.2
1,4-Dichlorobenzene	ND	9.5	ug/L	1.3
3,3'-Dichlorobenzidine	ND	48	ug/L	3.7
2,4-Dichlorophenol	ND	9.5	ug/L	1.3
Diethyl phthalate	ND	9.5	ug/L	1.1
2,4-Dimethylphenol	ND	9.5	ug/L	1.7
Dimethyl phthalate	ND	9.5	ug/L	1.2
Di-n-butyl phthalate	ND	9.5	ug/L	1.0
Di-n-octyl phthalate	ND	9.5	ug/L	0.90

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TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC/MS Semivolatiles

Lot-Sample #...: C2I200231-002 Work Order #...: E8KX21AJ Matrix.........: WATER

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	48	ug/L	1.5
4,6-Dinitro-2-methylphenol	ND	48	ug/L	1.3
2,4-Dinitrotoluene	ND	9.5	ug/L	1.2
2,6-Dinitrotoluene	ND	9.5	ug/L	1.3
Fluoranthene	ND	9.5	ug/L	1.1
Fluorene	ND	9.5	ug/L	1.5
Hexachlorobenzene	ND	9.5	ug/L	1.2
Hexachlorobutadiene	ND	9.5	ug/L	1.4
Hexachlorocyclopenta-diene	ND	48	ug/L	5.9
Hexachloroethane	ND	9.5	ug/L	1.3
Indeno(1,2,3-cd)pyrene	ND	9.5	ug/L	0.95
Isophorone	ND	9.5	ug/L	1.3
2-Methylnaphthalene	ND	9.5	ug/L	1.5
2-Methylphenol	ND	9.5	ug/L	1.5
4-Methylphenol	ND	9.5	ug/L	3.3
Naphthalene	ND	9.5	ug/L	1.4
2-Nitroaniline	ND	48	ug/L	1.0
3-Nitroaniline	ND	48	ug/L	2.6
4-Nitroaniline	ND	48	ug/L	1.1
Nitrobenzene	ND	9.5	ug/L	1.4
2-Nitrophenol	ND	9.5	ug/L	2.8
4-Nitrophenol	ND	48	ug/L	1.7
N-Nitrosodi-n-propyl-amine	ND	9.5	ug/L	1.5
N-Nitrosodiphenylamine	ND	9.5	ug/L	4.0
2,2'-oxybis(1-Chloropropane)	ND	9.5	ug/L	1.6
Pentachlorophenol	ND	48	ug/L	0.78
Phenanthrene	ND	9.5	ug/L	1.0
Phenol	ND	9.5	ug/L	1.9
Pyrene	ND	9.5	ug/L	0.89
1,2,4-Trichloro-benzene	ND	9.5	ug/L	1.3
2,4,5-Trichloro-phenol	ND	9.5	ug/L	1.3
2,4,6-Trichloro-phenol	ND	9.5	ug/L	1.4

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TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC/MS Semivolatiles

Lot-Sample #...: C2I200231-002 **Work Order #...:** E8KX21AJ **Matrix.........:** WATER

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
2,4,6-Tribromophenol	87	(21 - 122)
2-Fluorobiphenyl	74	(30 - 110)
2-Fluorophenol	62	(13 - 110)
Nitrobenzene-d5	75	(32 - 112)
Phenol-d5	70	(10 - 113)
Terphenyl-d14	73	(10 - 144)

NOTE(S):

J Estimated result. Result is less than RL.

TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-003	**Work Order #...:**	E8KX61AW	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/24/02	**Analysis Date..:**	09/26/02		
Prep Batch #...:	2267541	**Analysis Time..:**	22:39		
Dilution Factor:	1	**Initial Wgt/Vol:**	1000 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	010139	**Instrument ID..:**	G/H		
		Method.........:	SW846 8081A		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
alpha-BHC	ND	0.050	ug/L	0.0058
beta-BHC	ND	0.050	ug/L	0.0091
delta-BHC	ND	0.050	ug/L	0.0033
gamma-BHC (Lindane)	ND	0.050	ug/L	0.0067
Heptachlor	ND	0.050	ug/L	0.0073
Aldrin	ND	0.050	ug/L	0.0066
Heptachlor epoxide	ND	0.050	ug/L	0.0036
Endosulfan I	ND	0.050	ug/L	0.0098
Dieldrin	ND	0.050	ug/L	0.0076
4,4'-DDE	ND	0.050	ug/L	0.0045
Endrin	ND	0.050	ug/L	0.012
Endrin ketone	ND	0.050	ug/L	0.0039
Endrin aldehyde	ND	0.050	ug/L	0.0042
Endosulfan II	ND	0.050	ug/L	0.0073
4,4'-DDD	ND	0.050	ug/L	0.0098
Endosulfan sulfate	ND	0.050	ug/L	0.0059
4,4'-DDT	ND	0.050	ug/L	0.0045
Methoxychlor	ND	0.10	ug/L	0.011
alpha-Chlordane	ND	0.050	ug/L	0.0076
gamma-Chlordane	ND	0.050	ug/L	0.0089
Toxaphene	ND	2.0	ug/L	0.16

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	87	(39 - 130)
Decachlorobiphenyl	94	(10 - 147)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-002	**Work Order #...:**	E8KX21AK	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/24/02	**Analysis Date..:**	09/26/02		
Prep Batch #...:	2267541	**Analysis Time..:**	22:11		
Dilution Factor:	1	**Initial Wgt/Vol:**	1000 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	010139	**Instrument ID..:**	G/H		
		Method.........:	SW846 8081A		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
alpha-BHC	ND	0.050	ug/L	0.0058
beta-BHC	ND	0.050	ug/L	0.0091
delta-BHC	ND	0.050	ug/L	0.0033
gamma-BHC (Lindane)	ND	0.050	ug/L	0.0067
Heptachlor	ND	0.050	ug/L	0.0073
Aldrin	ND	0.050	ug/L	0.0066
Heptachlor epoxide	ND	0.050	ug/L	0.0036
Endosulfan I	ND	0.050	ug/L	0.0098
Dieldrin	ND	0.050	ug/L	0.0076
4,4'-DDE	ND	0.050	ug/L	0.0045
Endrin	ND	0.050	ug/L	0.012
Endrin ketone	ND	0.050	ug/L	0.0039
Endrin aldehyde	ND	0.050	ug/L	0.0042
Endosulfan II	ND	0.050	ug/L	0.0073
4,4'-DDD	ND	0.050	ug/L	0.0098
Endosulfan sulfate	ND	0.050	ug/L	0.0059
4,4'-DDT	ND	0.050	ug/L	0.0045
Methoxychlor	ND	0.10	ug/L	0.011
alpha-Chlordane	ND	0.050	ug/L	0.0076
gamma-Chlordane	ND	0.050	ug/L	0.0089
Toxaphene	ND	2.0	ug/L	0.16

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	95	(39 - 130)
Decachlorobiphenyl	99	(10 - 147)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-003	**Work Order #...:**	E8KX61AX	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/24/02	**Analysis Date..:**	09/26/02		
Prep Batch #...:	2267543	**Analysis Time..:**	18:00		
Dilution Factor:	1	**Initial Wgt/Vol:**	1000 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	010139	**Instrument ID..:**	M/N		
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	1.0	ug/L	0.19
Aroclor 1221	ND	1.0	ug/L	0.31
Aroclor 1232	ND	1.0	ug/L	0.14
Aroclor 1242	ND	1.0	ug/L	0.16
Aroclor 1248	ND	1.0	ug/L	0.23
Aroclor 1254	ND	1.0	ug/L	0.20
Aroclor 1260	ND	1.0	ug/L	0.15

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	80	(45 - 120)
Decachlorobiphenyl	104	(24 - 128)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-002	Work Order #...:	E8KX21AL	Matrix.........:	WATER
Date Sampled...:	09/19/02	Date Received..:	09/20/02	MS Run #.......:	
Prep Date......:	09/24/02	Analysis Date..:	09/26/02		
Prep Batch #...:	2267543	Analysis Time..:	17:40		
Dilution Factor:	1	Initial Wgt/Vol:	1000 mL	Final Wgt/Vol..:	10 mL
Analyst ID.....:	010139	Instrument ID..:	M/N		
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	1.0	ug/L	0.19
Aroclor 1221	ND	1.0	ug/L	0.31
Aroclor 1232	ND	1.0	ug/L	0.14
Aroclor 1242	ND	1.0	ug/L	0.16
Aroclor 1248	ND	1.0	ug/L	0.23
Aroclor 1254	ND	1.0	ug/L	0.20
Aroclor 1260	ND	1.0	ug/L	0.15

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	96	(45 - 120)
Decachlorobiphenyl	106	(24 - 128)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-003	**Work Order #...:**	E8KX61A0	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/24/02	**Analysis Date..:**	09/27/02		
Prep Batch #...:	2267544	**Analysis Time..:**	09:33		
Dilution Factor:	1	**Initial Wgt/Vol:**	1000 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	1797	**Instrument ID..:**	C/D		
		Method.........:	SW846 8151A		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-D	ND	4.0	ug/L	0.56
2,4,5-TP (Silvex)	ND	1.0	ug/L	0.14
2,4,5-T	ND	1.0	ug/L	0.14

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
DCAA	81	(53 - 119)

TETRA TECH NUS INC

Client Sample ID: BP-GM38D2-0902

GC Semivolatiles

Lot-Sample #...:	C2I200231-002	**Work Order #...:**	E8KX21AM	**Matrix.........:**	WATER
Date Sampled...:	09/19/02	**Date Received..:**	09/20/02	**MS Run #.......:**	
Prep Date......:	09/24/02	**Analysis Date..:**	09/27/02		
Prep Batch #...:	2267544	**Analysis Time..:**	09:05		
Dilution Factor:	1	**Initial Wgt/Vol:**	1000 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	1797	**Instrument ID..:**	C/D		
		Method.........:	SW846 8151A		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
2,4-D	ND	4.0	ug/L	0.56
2,4,5-TP (Silvex)	ND	1.0	ug/L	0.14
2,4,5-T	ND	1.0	ug/L	0.14

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
DCAA	83	(53 - 119)

STL-Pittsburgh

Metals Data Reporting Form

Sample Results

Lab Sample ID: E8KX6 **Client ID:** BP-GM38D-0902

Matrix: Water **Units:** ug/L **Prep Date:** 9/25/02 **Prep Batch:** 2268151

Weight: NA **Volume:** 100 **Percent Moisture:** NA

Element	WL/ Mass	IDL	Report Limit	Conc	Q	DF	Instr	Anal Date	Anal Time
Mercury	253.7	0.063	0.20	0.063	U	1	CVAA	9/25/02	11:08

Comments: Lot #: C2I200231 Sample #: 3

Version 4.97.1

U Result is less than the IDL
B Result is between IDL and RL

Form 1 Equivalent

STL-Pittsburgh

Metals Data Reporting Form

Sample Results

Lab Sample ID: E8KX2 **Client ID:** BP-GM38D2-0902

Matrix: Water **Units:** ug/L **Prep Date:** 9/25/02 **Prep Batch:** 2268151

Weight: NA **Volume:** 100 **Percent Moisture:** NA

Element	WL/ Mass	IDL	Report Limit	Conc	Q	DF	Instr	Anal Date	Anal Time
Mercury	253.7	0.063	0.20	0.063	U	1	CVAA	9/25/02	11:07

Comments: Lot #: C2I200231 Sample #: 2

Version 4.97.1

U Result is less than the IDL
B Result is between IDL and RL

Form 1 Equivalent

STL-Pittsburgh

Metals Data Reporting Form

Sample Results

Lab Sample ID: E8KX6 **Client ID:** BP-GM38D-0902

Matrix: Water **Units:** ug/L **Prep Date:** 9/24/02 **Prep Batch:** 2267126

Weight: NA **Volume:** 50 **Percent Moisture:** NA

Element	WL/ Mass	IDL	Report Limit	Conc	Q	DF	Instr	Anal Date	Anal Time
Aluminum	308.22	33.6	200	33.6	U	1	ICPST	9/27/02	12:47
Antimony	220.35	1.9	10.0	1.9	U	1	ICPST	9/27/02	12:47
Arsenic	189.04	2.6	10.0	2.6	U	1	ICPST	9/27/02	12:47
Barium	**493.41**	**0.19**	**200**	**6.5**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Beryllium	313.04	0.70	4.0	0.70	U	1	ICPST	9/27/02	12:47
Cadmium	226.50	0.41	5.0	0.41	U	1	ICPST	9/27/02	12:47
Calcium	**317.93**	**27.4**	**5000**	**4500**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Chromium	**267.72**	**0.53**	**5.0**	**0.58**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Cobalt	228.62	1.1	50.0	1.1	U	1	ICPST	9/27/02	12:47
Copper	324.75	1.3	25.0	1.3	U	1	ICPST	9/27/02	12:47
Iron	271.44	17.3	100	17.3	U	1	ICPST	9/27/02	12:47
Lead	220.35	1.3	3.0	1.3	U	1	ICPST	9/27/02	12:47
Magnesium	**279.08**	**17.2**	**5000**	**1210**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Manganese	**257.61**	**0.25**	**15.0**	**1.1**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Nickel	231.60	1.4	40.0	1.4	U	1	ICPST	9/27/02	12:47
Potassium	**766.49**	**34.0**	**5000**	**736**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Selenium	**220.35**	**3.5**	**5.0**	**3.7**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Silver	328.07	0.50	5.0	0.50	U	1	ICPST	9/27/02	12:47
Sodium	**330.23**	**122**	**5000**	**12900**		**1**	**ICPST**	**9/27/02**	**12:47**
Thallium	**190.86**	**5.3**	**10.0**	**6.0**	**B**	**1**	**ICPST**	**9/27/02**	**12:47**
Vanadium	292.40	1.4	50.0	1.4	U	1	ICPST	9/27/02	12:47
Zinc	213.86	2.8	20.0	2.8	U	1	ICPST	9/27/02	12:47

Comments: Lot #: C2I200231 Sample #: 3

Version 4.97.1

U Result is less than the IDL
B Result is between IDL and RL

Form 1 Equivalent

STL-Pittsburgh

Metals Data Reporting Form

Sample Results

Lab Sample ID: E8KX2 **Client ID:** BP-GM38D2-0902

Matrix: Water **Units:** ug/L **Prep Date:** 9/24/02 **Prep Batch:** 2267126

Weight: NA **Volume:** 50 **Percent Moisture:** NA

Element	WL/ Mass	IDL	Report Limit	Conc	Q	DF	Instr	Anal Date	Anal Time
Aluminum	**308.22**	**33.6**	**200**	**46.3**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Antimony	220.35	1.9	10.0	1.9	U	1	ICPST	9/27/02	12:26
Arsenic	189.04	2.6	10.0	2.6	U	1	ICPST	9/27/02	12:26
Barium	**493.41**	**0.19**	**200**	**2.9**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Beryllium	313.04	0.70	4.0	0.70	U	1	ICPST	9/27/02	12:26
Cadmium	226.50	0.41	5.0	0.41	U	1	ICPST	9/27/02	12:26
Calcium	**317.93**	**27.4**	**5000**	**2940**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Chromium	**267.72**	**0.53**	**5.0**	**0.74**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Cobalt	**228.62**	**1.1**	**50.0**	**3.5**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Copper	324.75	1.3	25.0	1.3	U	1	ICPST	9/27/02	12:26
Iron	**271.44**	**17.3**	**100**	**21.5**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Lead	220.35	1.3	3.0	1.3	U	1	ICPST	9/27/02	12:26
Magnesium	**279.08**	**17.2**	**5000**	**1030**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Manganese	**257.61**	**0.25**	**15.0**	**8.1**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Nickel	**231.60**	**1.4**	**40.0**	**2.4**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Potassium	**766.49**	**34.0**	**5000**	**573**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**
Selenium	220.35	3.5	5.0	3.5	U	1	ICPST	9/27/02	12:26
Silver	328.07	0.50	5.0	0.50	U	1	ICPST	9/27/02	12:26
Sodium	**330.23**	**122**	**5000**	**8730**		**1**	**ICPST**	**9/27/02**	**12:26**
Thallium	190.86	5.3	10.0	5.3	U	1	ICPST	9/27/02	12:26
Vanadium	292.40	1.4	50.0	1.4	U	1	ICPST	9/27/02	12:26
Zinc	**213.86**	**2.8**	**20.0**	**2.9**	**B**	**1**	**ICPST**	**9/27/02**	**12:26**

Comments: Lot #: C2I200231 Sample #: 2

Version 4.97.1

U Result is less than the IDL
B Result is between IDL and RL

Form I Equivalent

NWIRP Beth Page

Cyanide, Total

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: SW846 9012A
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21CF	4.0 B J	ug/L	10.0	1	9/25/02 - 9/28/02 10:42	2268212
BP-GM38D-0902	003	E8KX61CF	2.0 B J	ug/L	10.0	1	9/25/02 - 9/28/02 10:43	2268212

B Estimated result. Result is less than RL and greater than or equal to the IDL.
J Method blank contamination. The associated method blank contains the target analyte at a reportable level.

NWIRP Beth Page

Total Sulfide

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: SW846 9030B/9034
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21CG	4.0	mg/L	1.0	1	9/21/02 - 9/21/02 17:00	2264193
BP-GM38D-0902	003	E8KX61CG	ND	mg/L	1.0	1	9/21/02 - 9/21/02 17:00	2264193

NWIRP Beth Page

TOC

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: MCAWW 415.1
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AH	0.96 B	mg/L	1.0	1	9/25/02 - 9/25/02 16:45	2269268
BP-GM38D-0902	003	E8KX61AU	0.36 B	mg/L	1.0	1	9/25/02 - 9/25/02 16:58	2269268

B Estimated result. Result is less than RL and greater than or equal to the IDL.

NWIRP Beth Page

Chemical Oxygen Demand (COD)

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: MCAWW 410.4
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AG	102	mg/L	10.0	1	9/21/02 - 9/21/02 16:00	2264184
BP-GM38D-0902	003	E8KX61AT	270	mg/L	10.0	1	9/21/02 - 9/21/02 16:00	2264184

NWIRP Beth Page

Biochemical Oxygen Demand

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: MCAWW 405.1
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AF	ND	mg/L	2.0	1	9/20/02 - 9/25/02 07:30	2263472
BP-GM38D-0902	003	E8KX61AR	ND	mg/L	2.0	1	9/20/02 - 9/25/02 07:30	2263472

NWIRP Beth Page

Total Dissolved Solids

Lab Name:	STL PITTSBURGH	**Method:**	MCAWW 160.1
Client Name:	TETRA TECH NUS INC	**Lot Number:**	C2I200231
Matrix:	WATER	**Date/Time Received:**	9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AC	ND	mg/L	10.0	1	9/23/02 - 9/23/02 10:30	2264104
BP-GM38D-0902	003	E8KX61AN	56.0	mg/L	10.0	1	9/23/02 - 9/23/02 10:30	2264104

NWIRP Beth Page

Total Suspended Solids

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: MCAWW 160.2
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AD	ND	mg/L	4.0	1	9/21/02 - 9/23/02 10:30	2264102
BP-GM38D-0902	003	E8KX61AP	ND	mg/L	4.0	1	9/21/02 - 9/23/02 10:30	2264102

NWIRP Beth Page

Total Alkalinity

Lab Name: STL PITTSBURGH
Client Name: TETRA TECH NUS INC
Matrix: WATER

Method: MCAWW 310.1
Lot Number: C2I200231
Date/Time Received: 9/20/02 9:45:00AM

Client Sample ID	Sample Number	Workorder	Result	Units	Reporting Limit	Dilution Factor	Prep Date - Analysis Date/Time	QC Batch
BP-GM38D2-0902	002	E8KX21AE	ND	mg/L	5.0	1	9/21/02 - 9/21/02 18:00	2264191
BP-GM38D-0902	003	E8KX61AQ	ND	mg/L	5.0	1	9/21/02 - 9/21/02 18:00	2264191

APPENDIX B

COMPUTER MODEL RESULTS

1.0 INTRODUCTION

Arcadis Geraghty & Miller (AGM) prepared a computer model to address groundwater and contaminant migration potentially associated with the NWIRP Bethpage and Northrop Grumman Sites. Development, evaluation, and validation of this model were addressed separately by AGM. As part of the GM-38 Area Remedy analysis, TtNUS tasked AGM to conduct computer model runs to locate optimum areas for capture of contaminated groundwater in the GM-38 Area. AGM conducted this activity and finalized the results in December 2002. This Appendix presents the findings of this model run.

2.0 RESULTS

Figures B-1a and B-1b present the results of an optimized model run to extract and re-inject GM-38 Area contaminated groundwater. Both figures present results for the same simulation with a combined pumping rate of 1100 gpm; however, Figure B-1b also provides an overlay of groundwater injection pathways.

Figures B-2, B-2a, B-2b, B-3, B-3a, and B-3b present annual estimated capture zones over a 10 year period for Recovery Wells 1 and 2, respectively. These figures serve as the basis for the capture zone estimates presented in Figures 3-1, 3-2, and 3-3 in the text of this report.

Figures B-4 through B-7 present chemical concentrations estimated by AGM in the GM-38 Area for each model layer prior to the start of a groundwater remedy. The iso-concentration contours by AGM are generally similar to the areas estimated by TtNUS. The primary difference between the areas results from the method of interpolating and extrapolating chemical data between specific vertical profile boring and monitoring well data. TtNUS has concluded that better estimates can only be determined through either an extensive field investigation or actual operation of a treatment system.

The AGM estimated iso-concentration contours that were presented in Figures B-4 through B-7 serve as the basis for predicted future concentrations of VOCs at selected locations presented in Figures 8 though 17. These figures also present chemical concentration estimates over time based on assumed pumping durations of 5, 15, and 30 years to identify potential effects of discontinuing the GM-38 remedy.

Figures 8 to 12 provide concentration estimates at the selected recovery wells and injection wells locations and rates. To determine whether the injection wells were located too close to the remedial system and thereby interfere with optimum extraction of contaminated groundwater, a set of model runs was conducted in which the treated groundwater would not be re-injected, (Figure 13 to 17). A comparison of the results from Figure 8 to 12 (with re-injection) versus 13 to 17 (without re-injection) suggest only minimal impact associated with re-injection of treated groundwater at that location.

B-2

ARCADIS
Project: Northrop Grumman Regional
Description: GM38 10-year capture zone
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 4

FIGURE B-1a

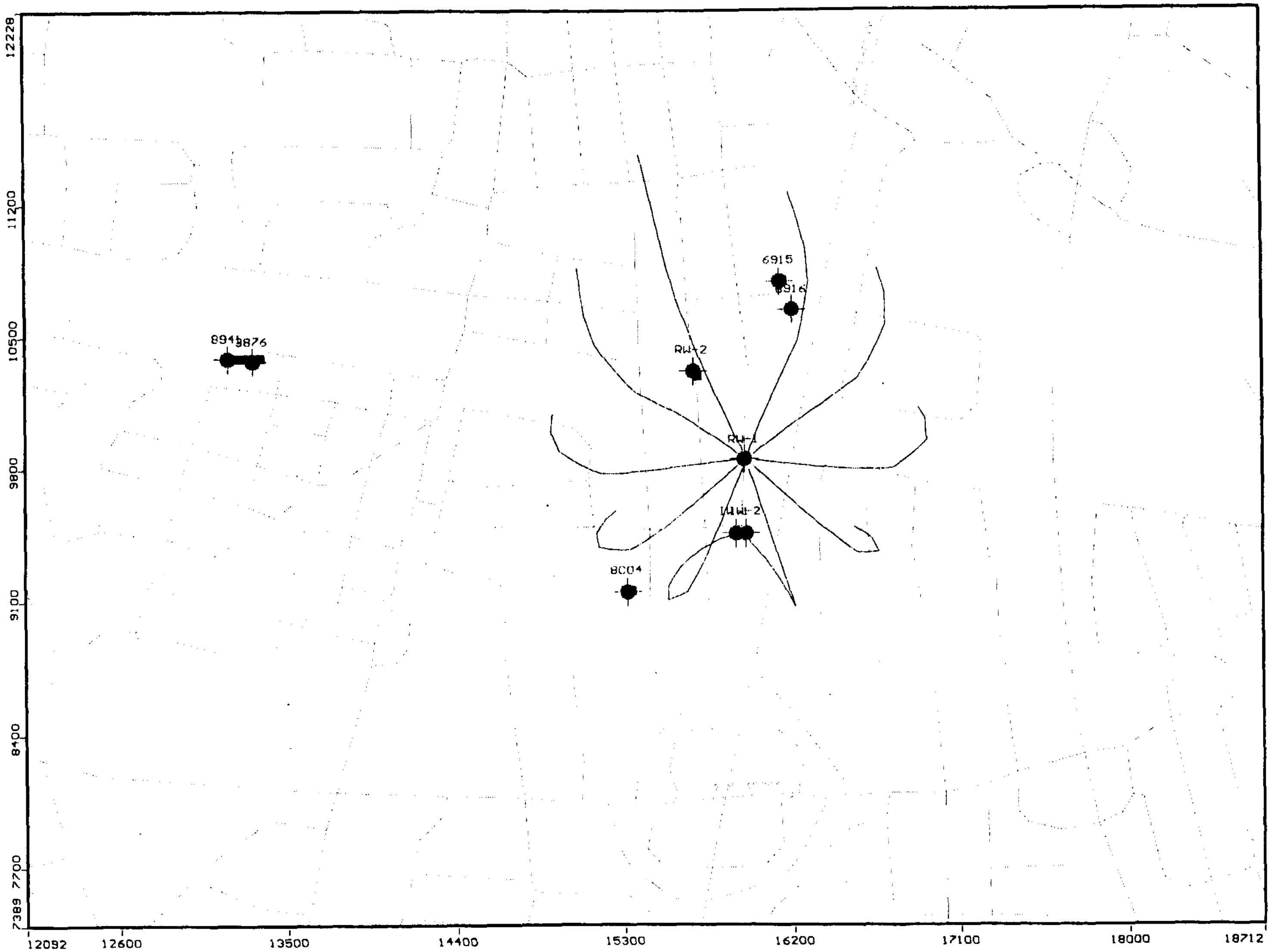
Projection of RW-1 and RW-2 10-year Capture Zones
Arrows represent 1 year of travel

ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone and Recharge
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 2

FIGURE B-1b

D[illegible]ction of RW-1 and RW2 10-year Capture Zone [illegible] Path of Recharged groundwater



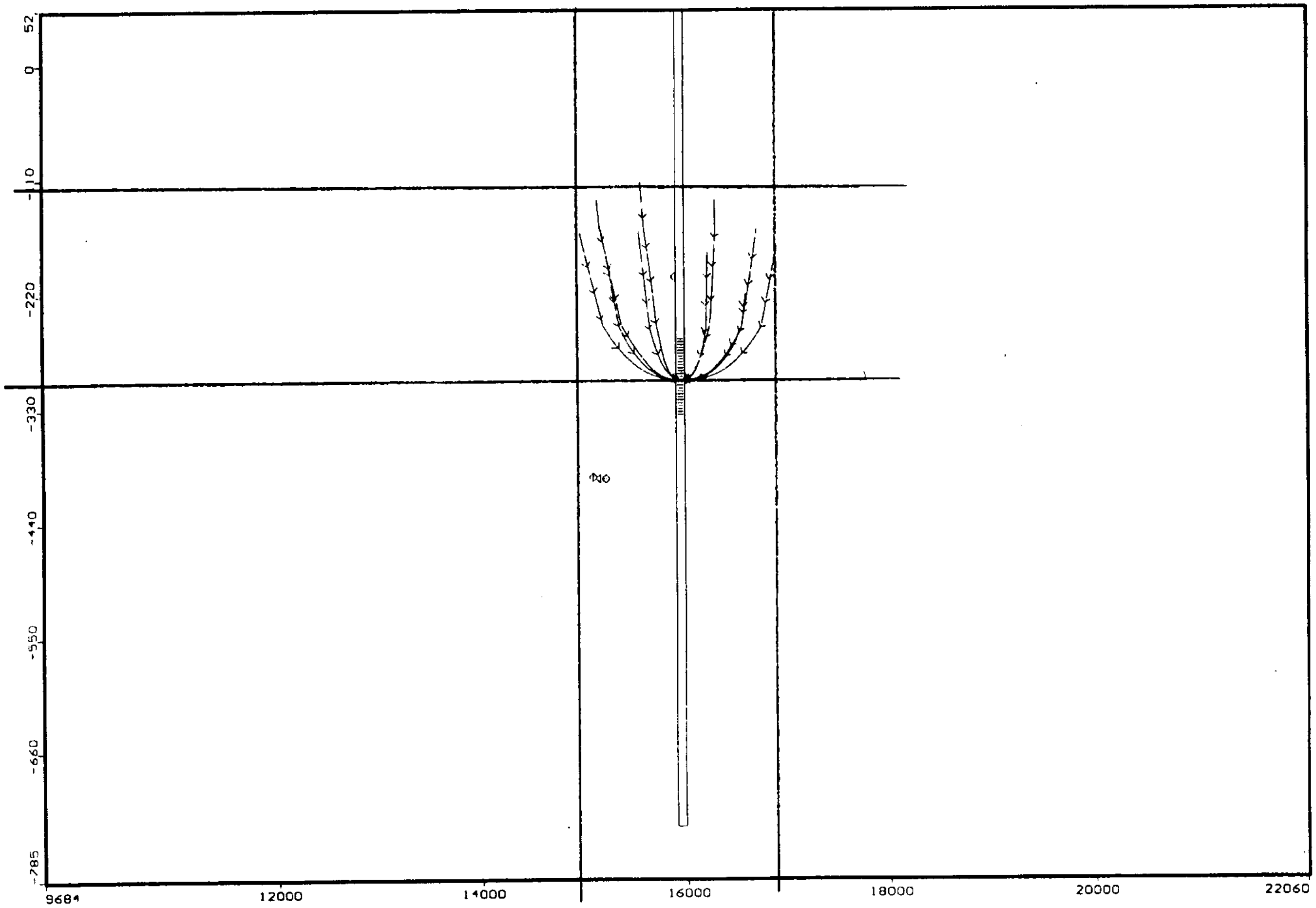
ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 8

FIGURE B-2

Projection of RW 1 10-year capture zone.

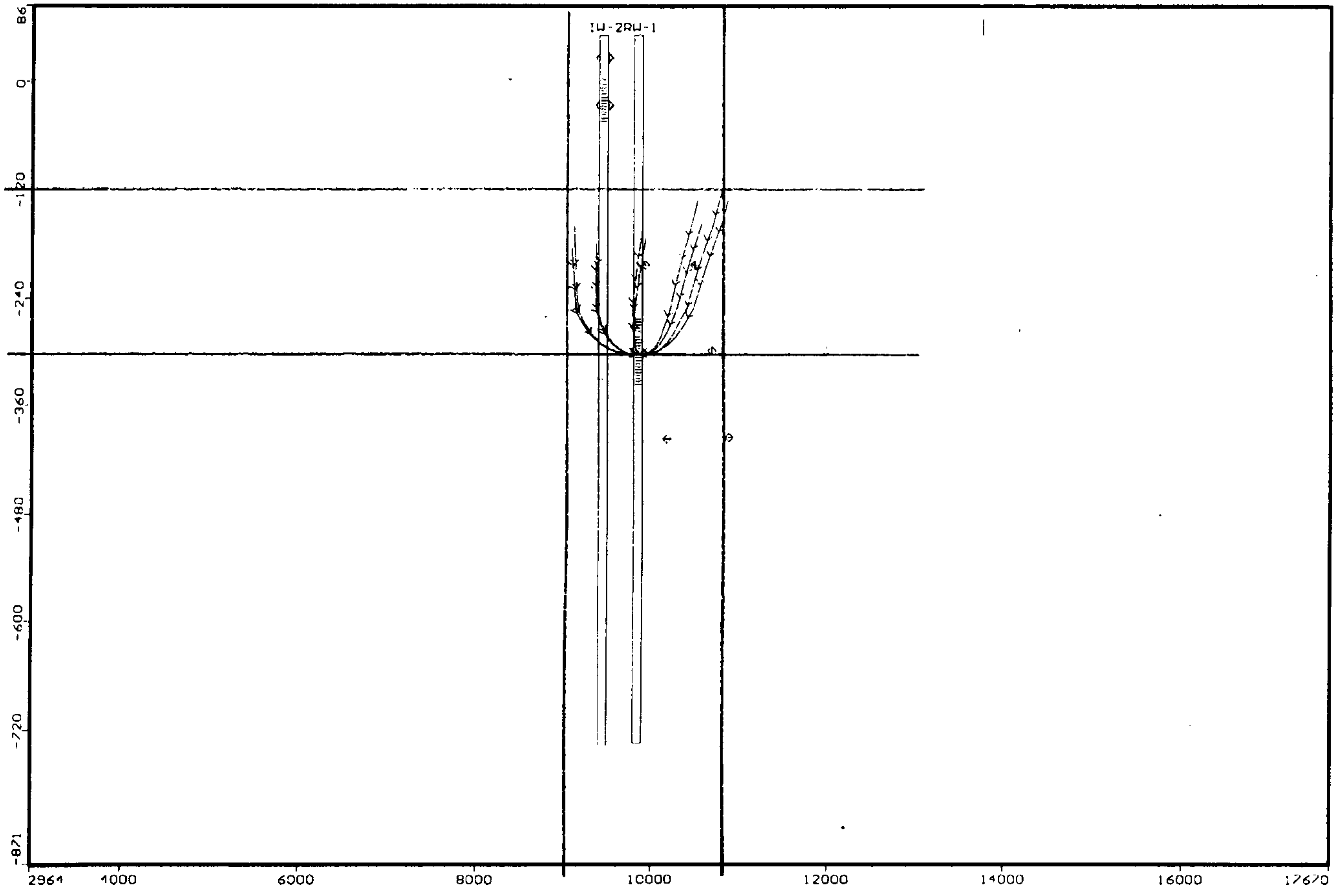
B-5



ARCADIS
Project: Northrop Grumman Regional
Description: RW-1, 5-year capture zone
24 Oct 02
Looking South

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Row: 132
1" ≈ 1200 ft

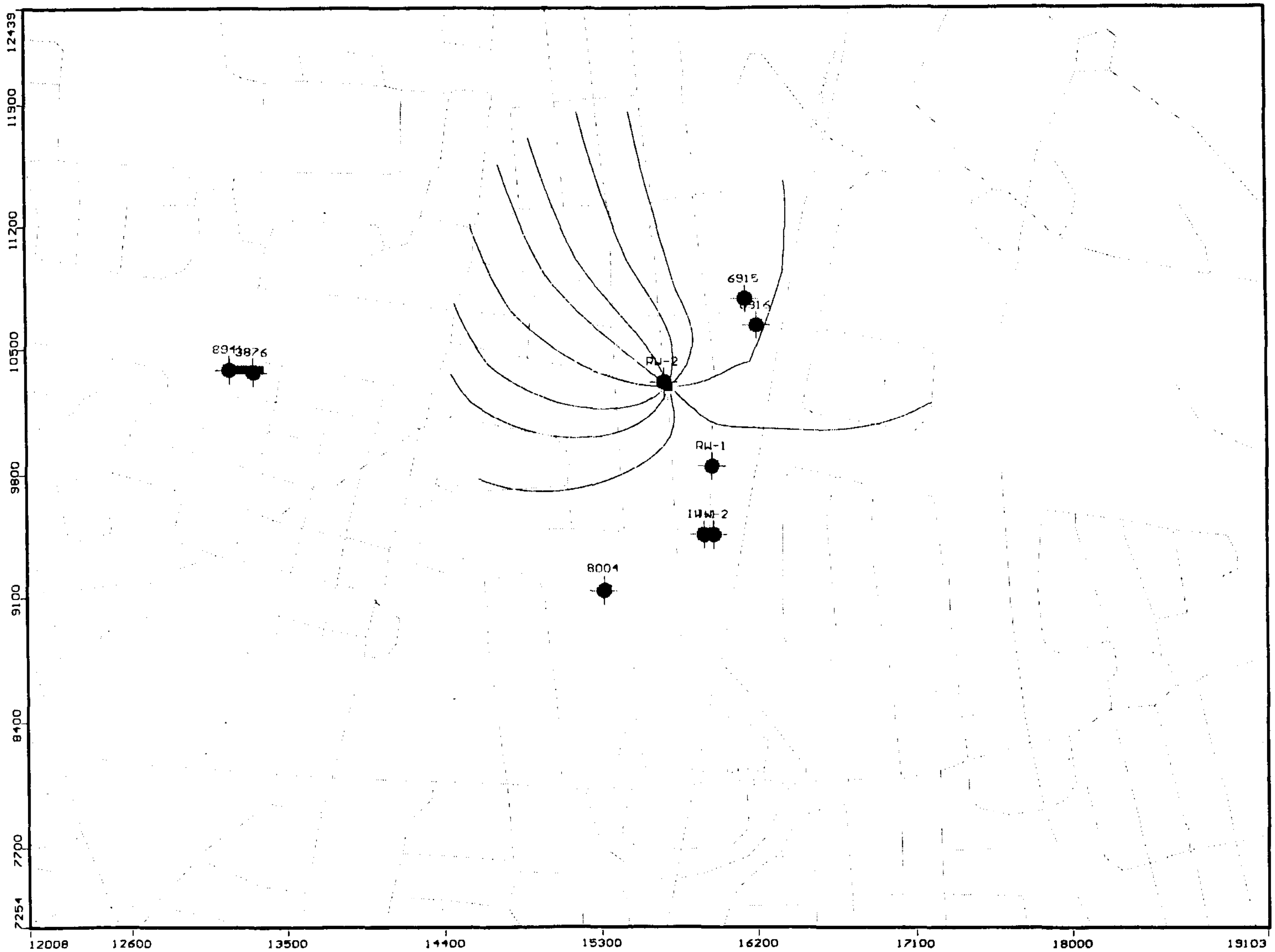
Figure B-2a



ARCADIS Project: Northrop Grumman Regional Description: RW-1, 5-year capture zone 24 Oct 02 Looking West	Visual MODFLOW v.2.8.2, (C) 1995-1999 Waterloo Hydrogeologic, Inc. NC: 226 NR: 280 NL: 11 Current Column: 151 1" ≈ 2100 feet

Figure B-26

B-8

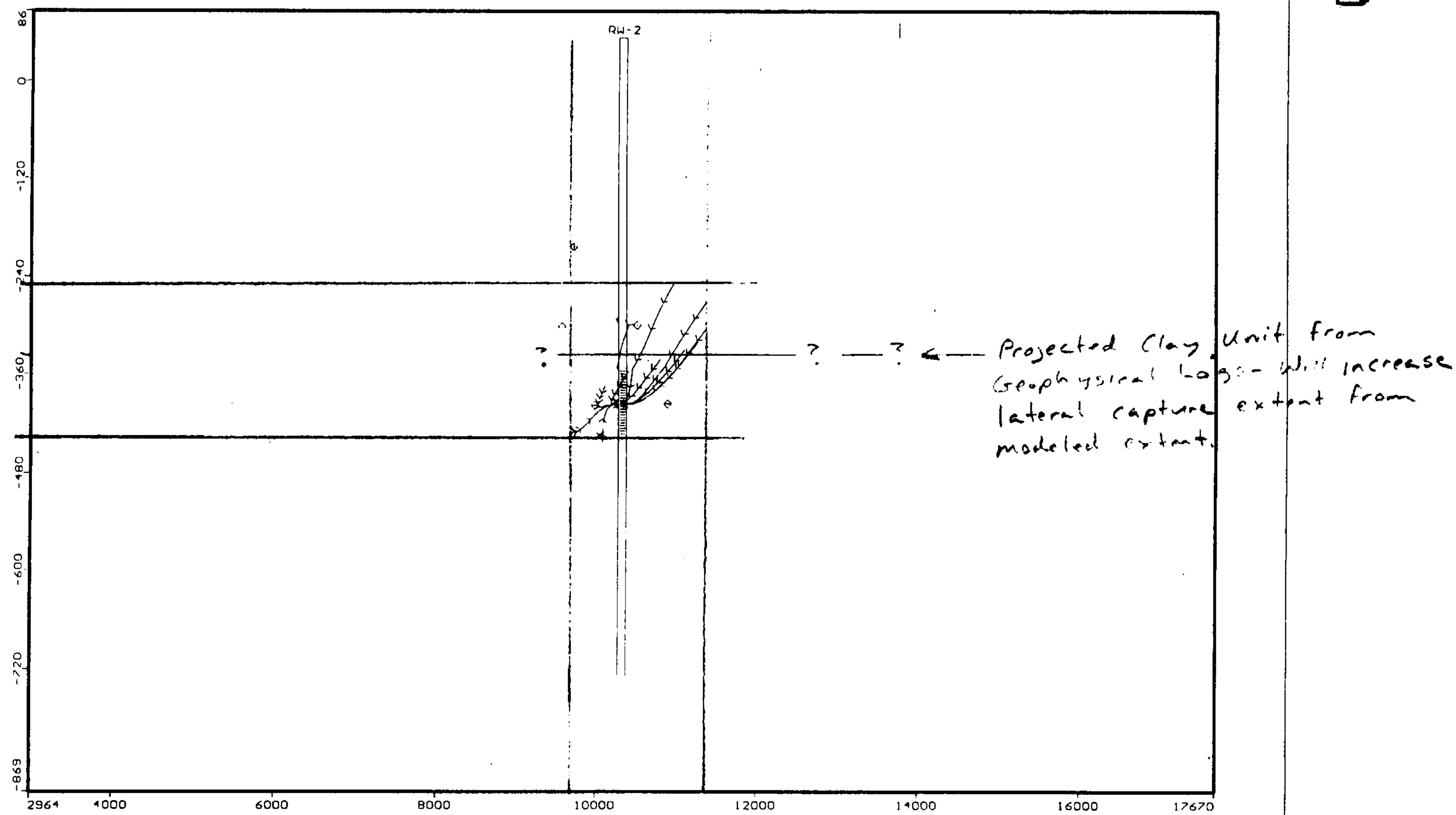


ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 8

FIGURE B-3

Projection of RW2 10-year capture zone



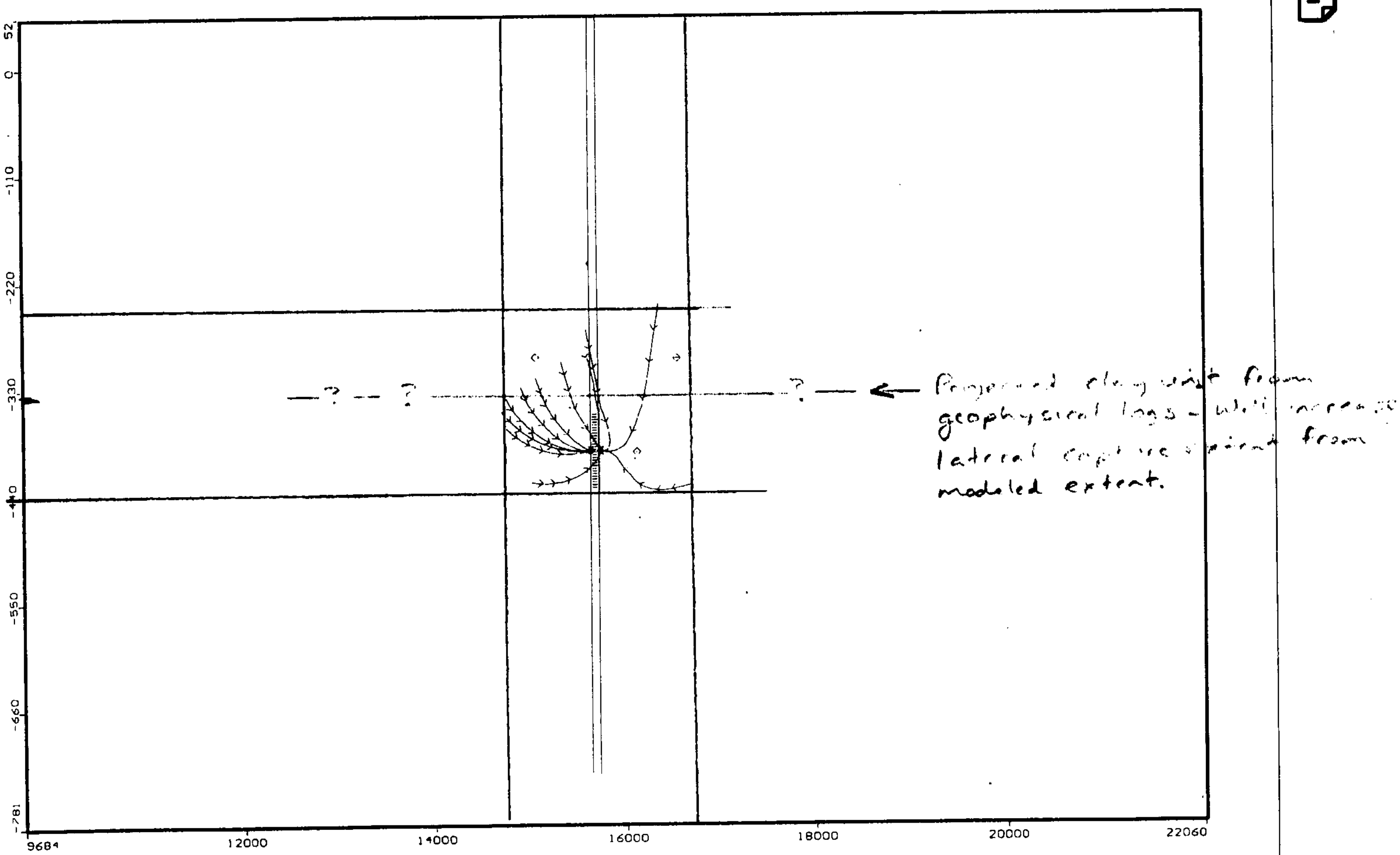
ARCADIS
Project: Northrop Grumman Regional
Description: RW-2, 5-year capture zone
24 Oct 02

Looking West

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Column: 146

1" ~ 2100 ft

Figure B-3a



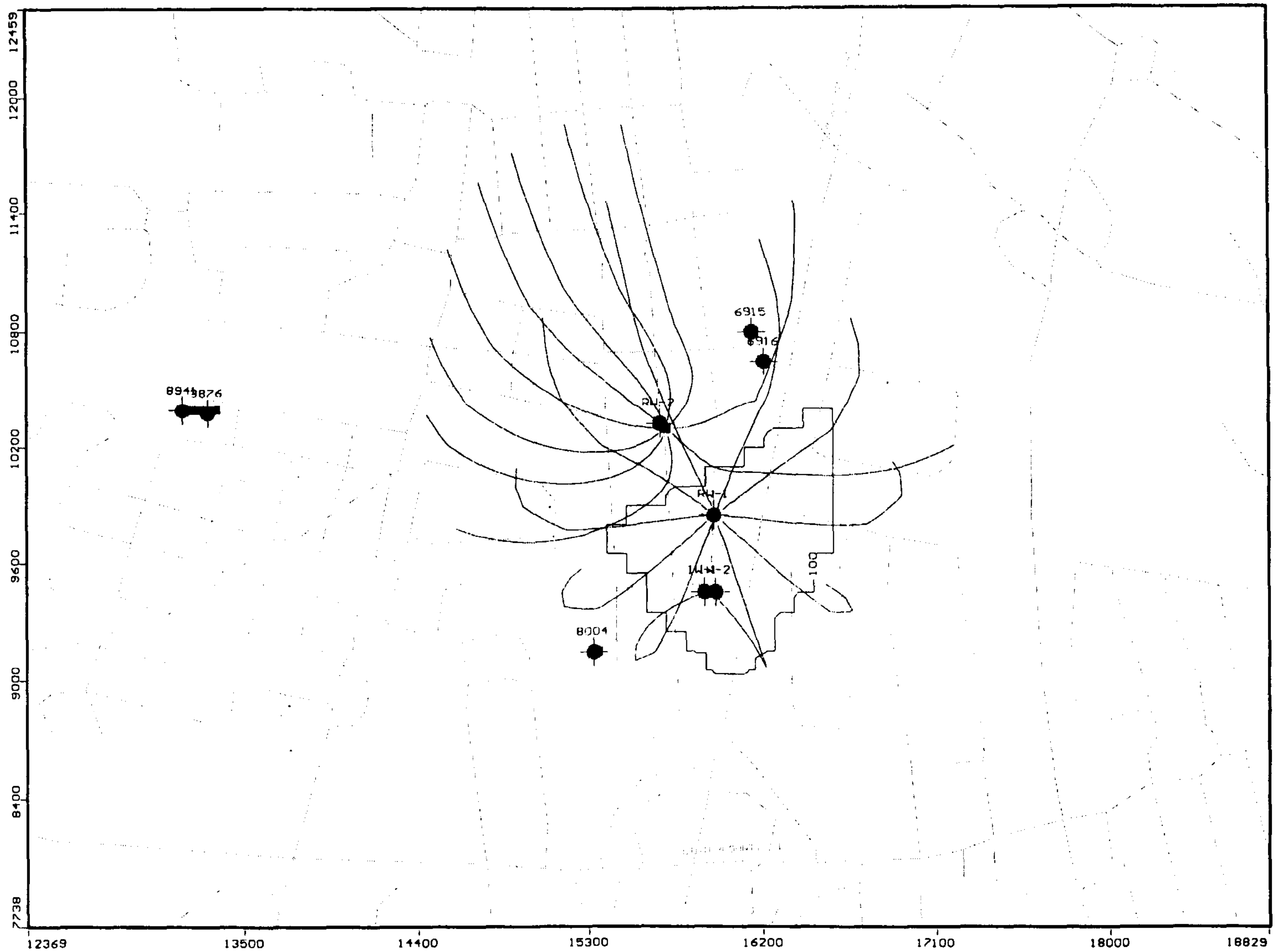
ARCADIS
Project: Northrop Grumman Regional
Description: RW-2, 5-year capture zone
24 Oct 02

Looking South

Visual MODFLOW v.2.8.2, (C) 1995-1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Row: 123

1" ~ 1800 ft.

Figure B-26



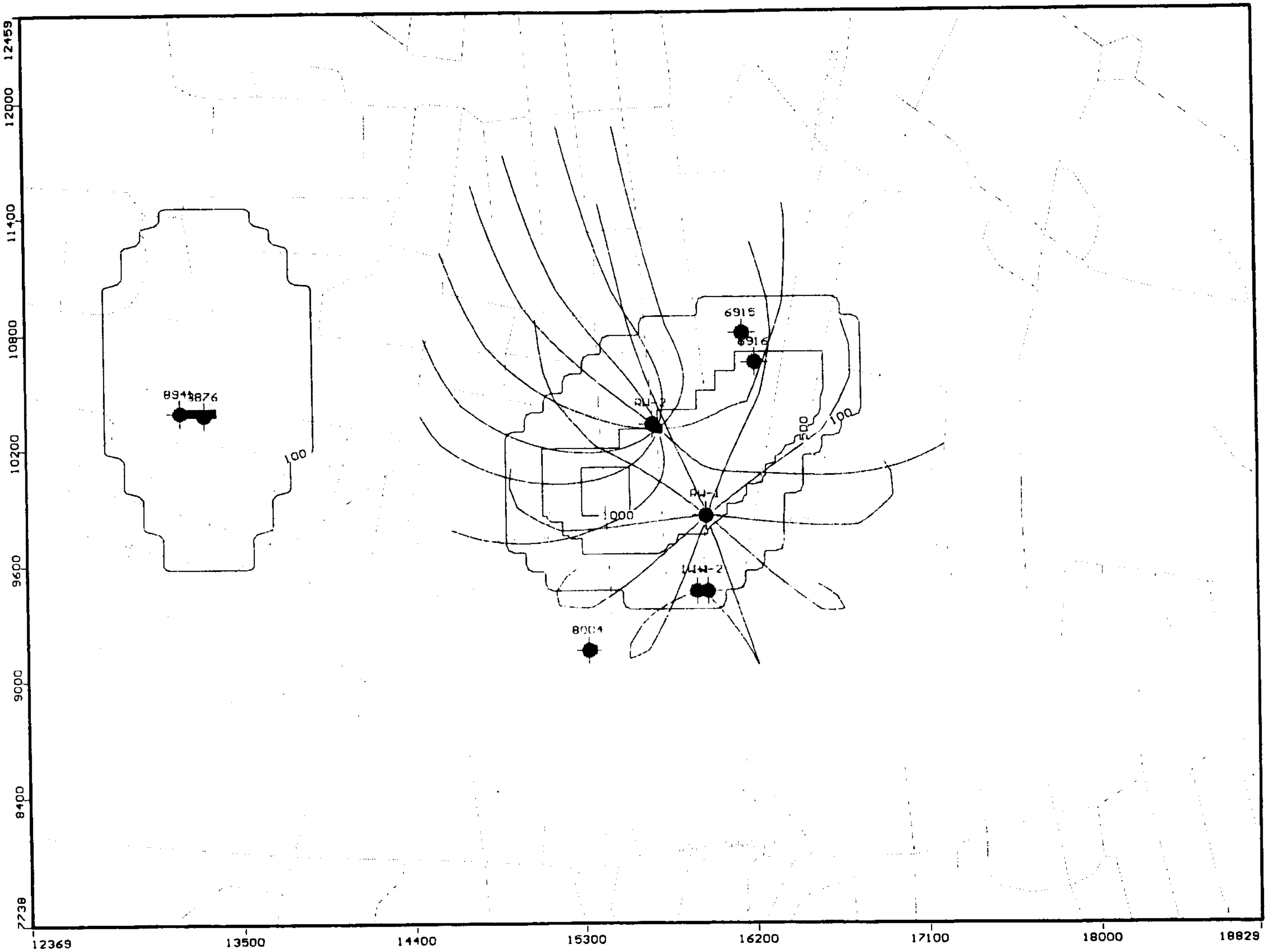
ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone and Plume
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 4

FIGURE 8-4

10 year capture zone, with TVOC plume in Model Layer 4, concentrations in micrograms per liter.

11-9



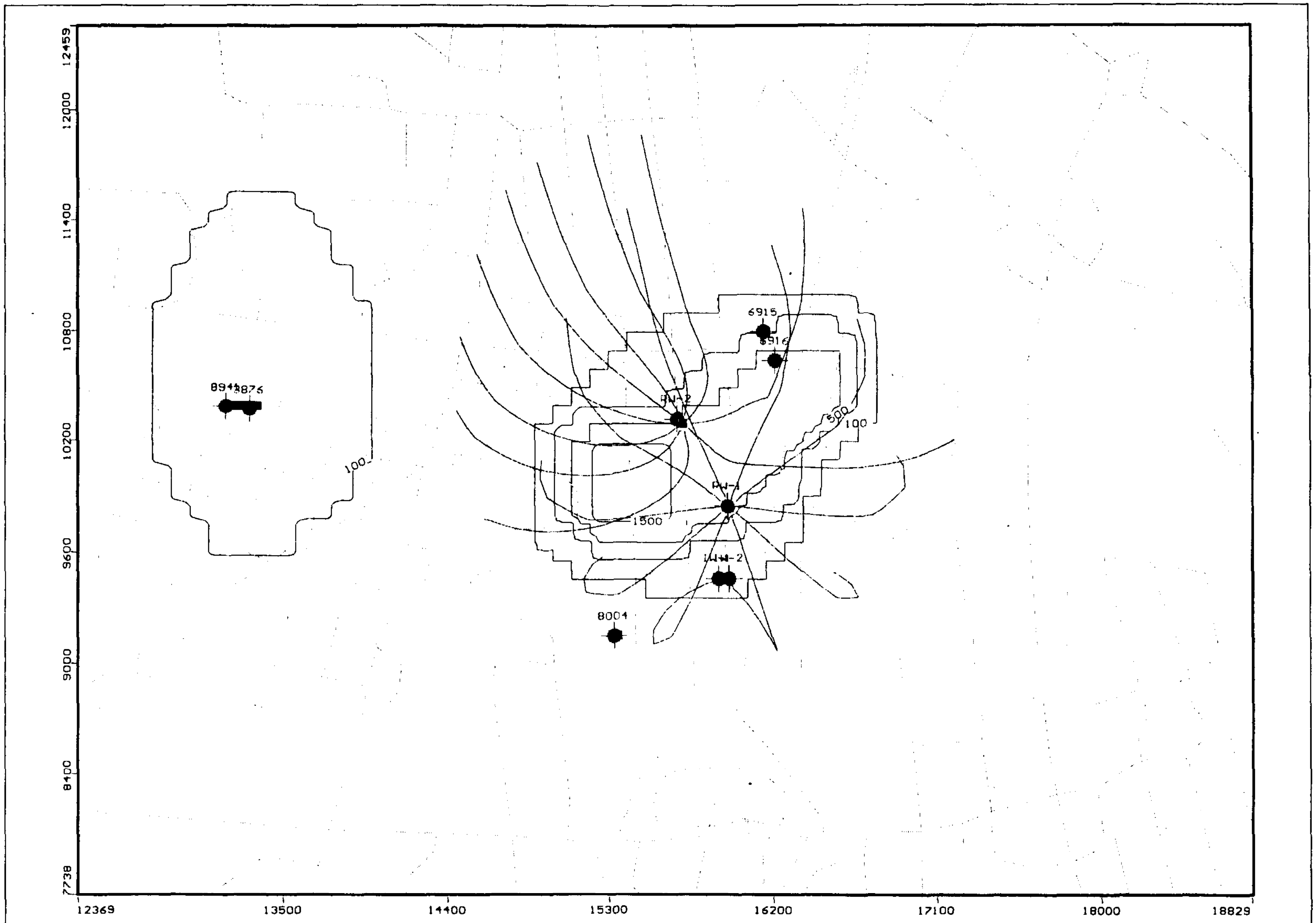
ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone and Plume
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 5

FIGURE B-5

year capture zone, with TVOC plume in model la. 5, concentration in micrograms per liter

B-13

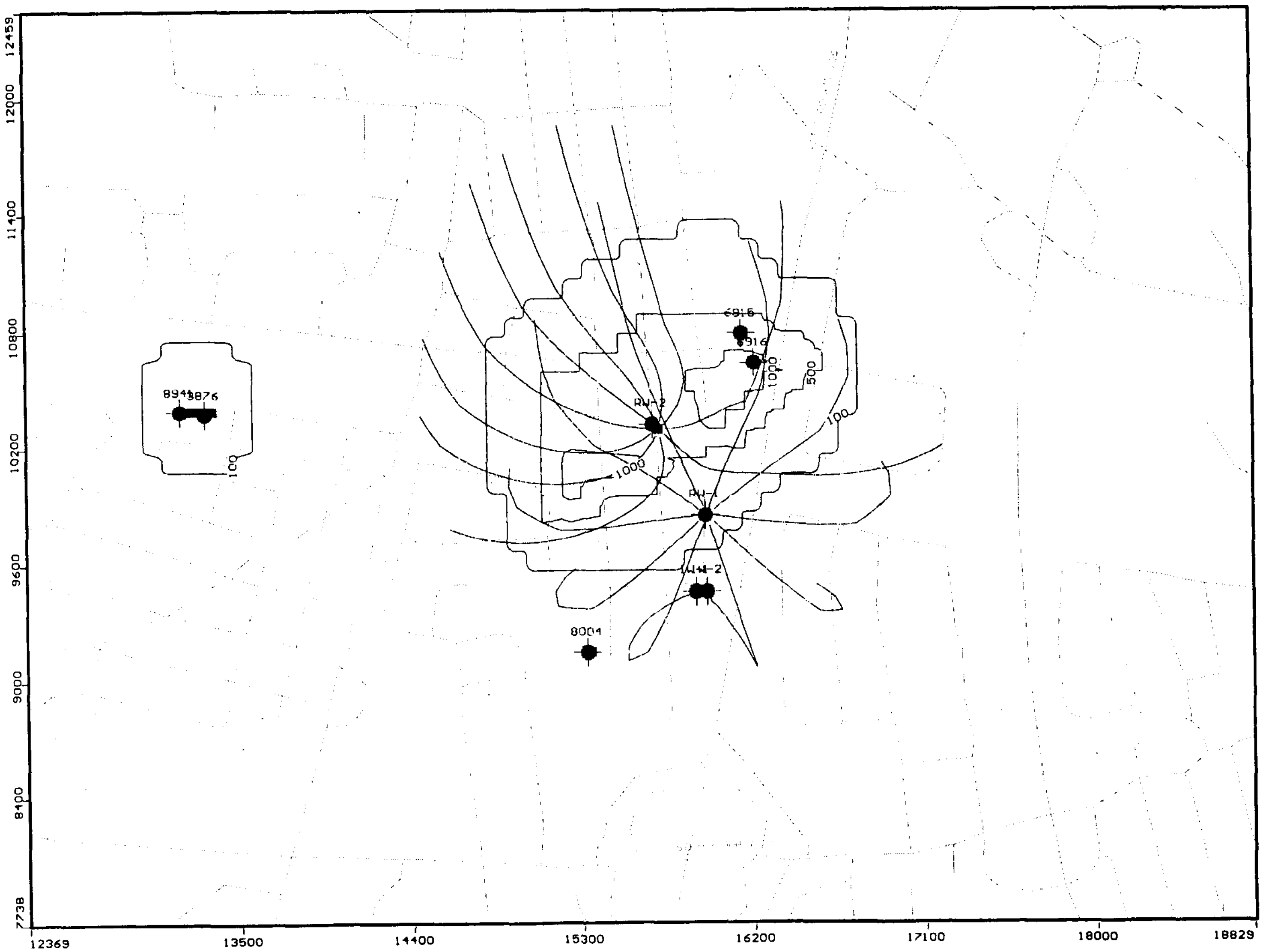


ARCADIS
Project: Northrop Grumman Regional
Description: Capture Zone and Plume
2 Dec 02

Visual MODFLOW v.2.8.2, (C) 1995–1999
Waterloo Hydrogeologic, Inc.
NC: 226 NR: 280 NL: 11
Current Layer: 6

FIGURE B-6

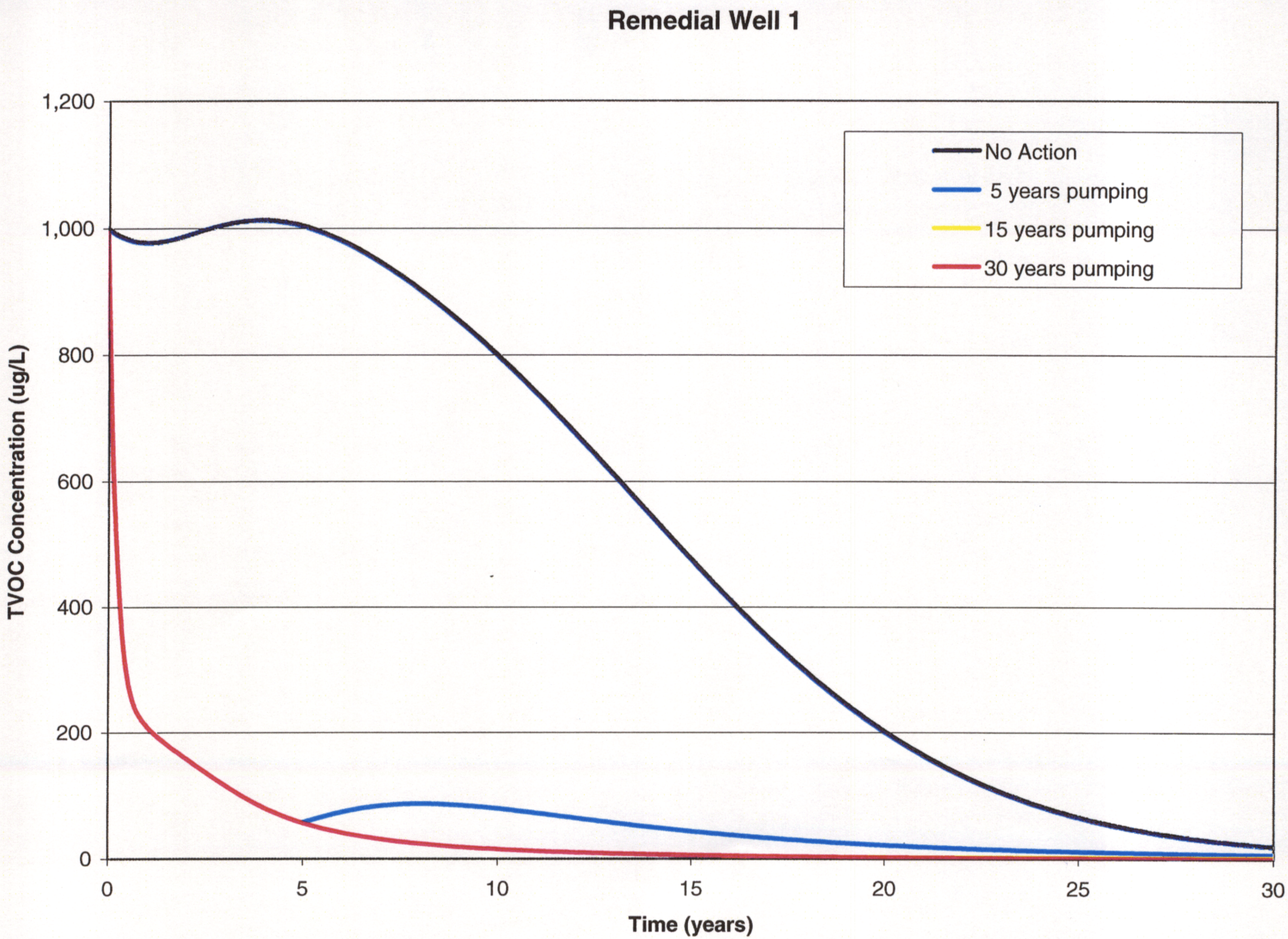
10 year capture zone, with TVOC plume in Model Layer 6, concentrations in micrograms per Liter.



ARCADIS Project: Northrop Grumman Regional Description: Capture Zone and Plume 2 Dec 02	Visual MODFLOW v.2.8.2, (C) 1995–1999 Waterloo Hydrogeologic, Inc. NC: 226 NR: 280 NL: 11 Current Layer: 7

FIGURE B-7

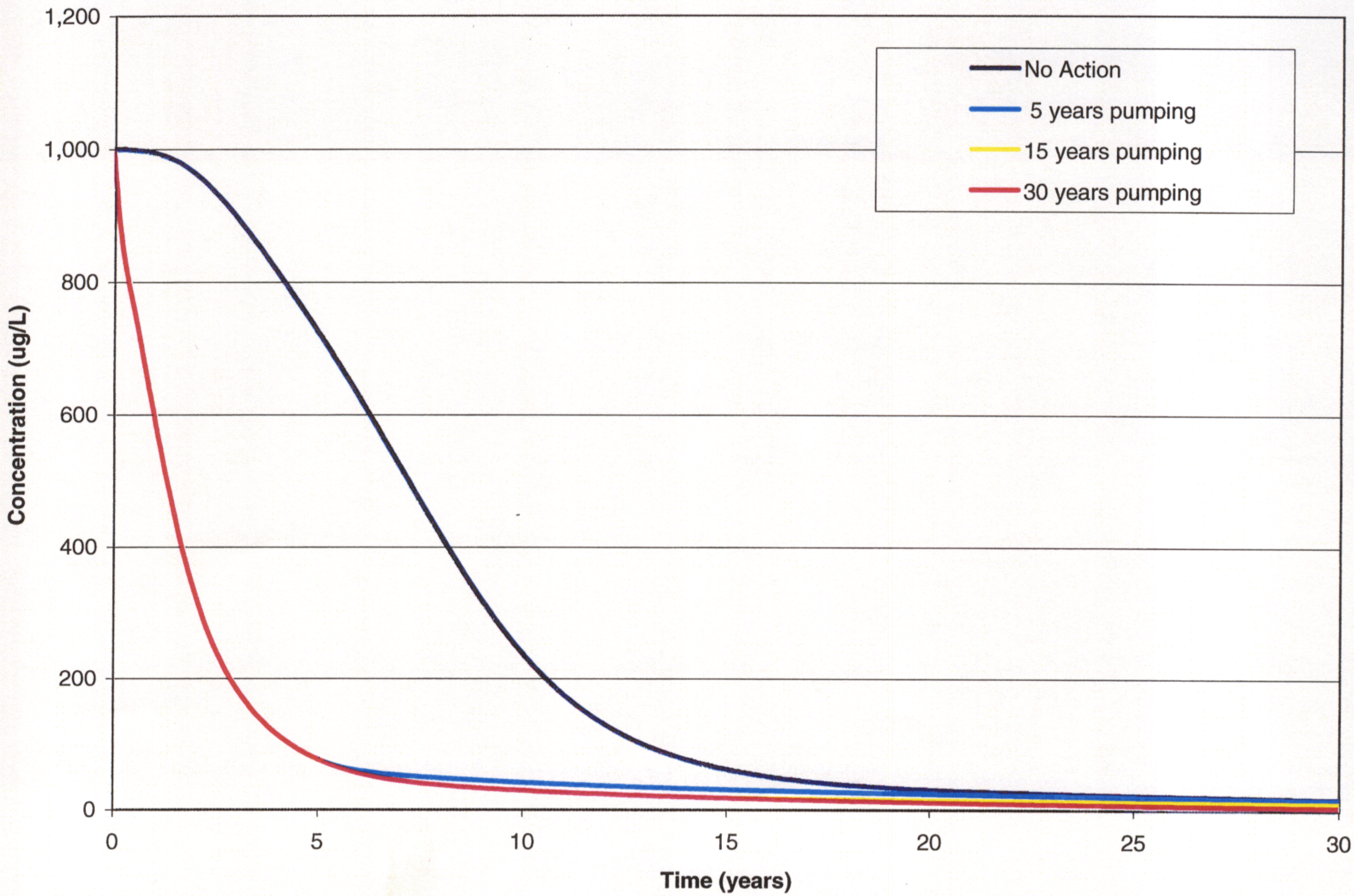
1C , a capture zone, with TVOC plume in Model Layer , concentrations in micrograms per Liter.



B-15

Figure No. 8
12/02/2002
Revised remedial system with injection wells

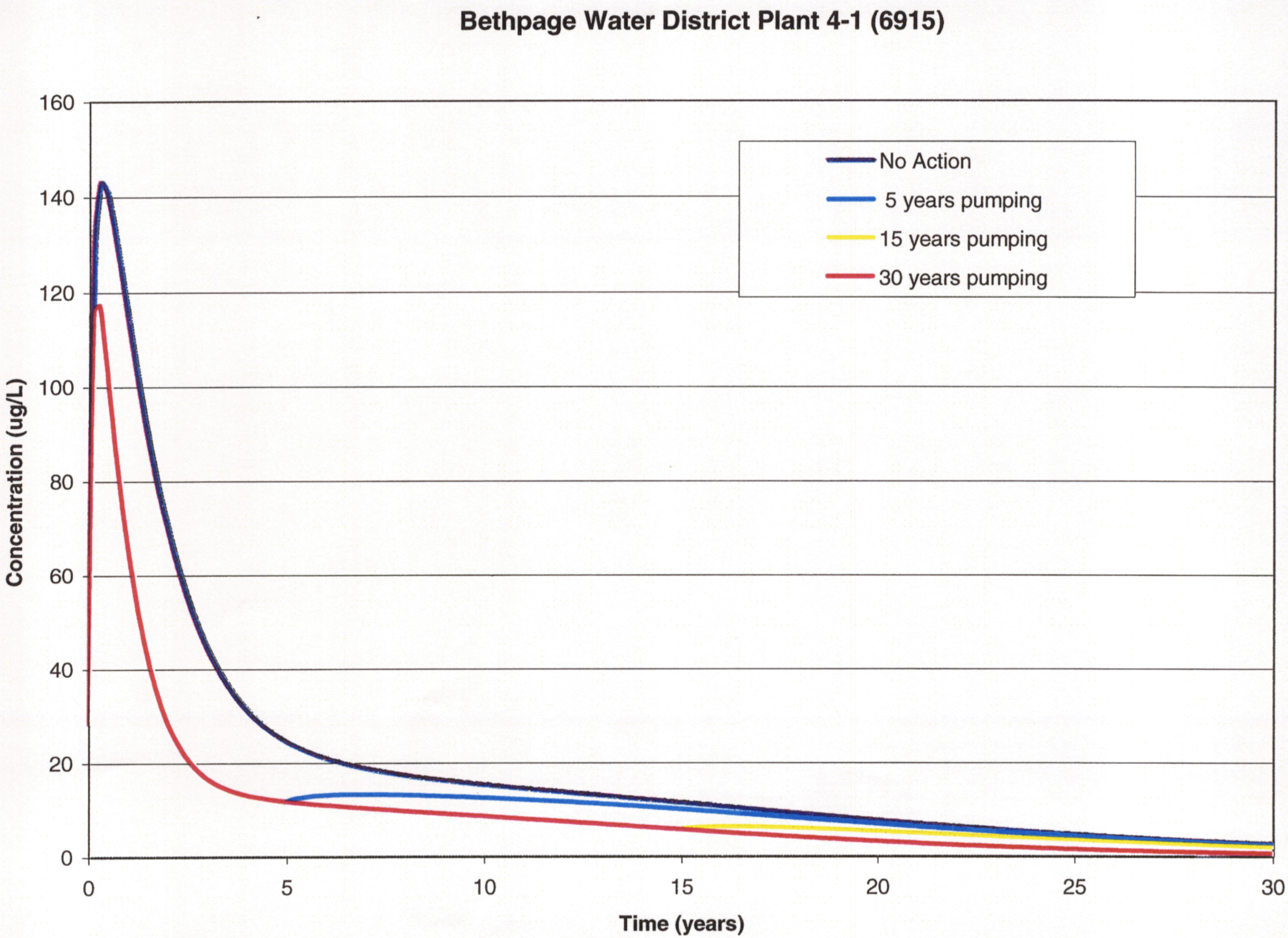
Remedial Well 2



B-16

Figure No. 9
12/02/2002
Revised remedial system with injection wells

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-3\output comparison\comparison.xls- RW2

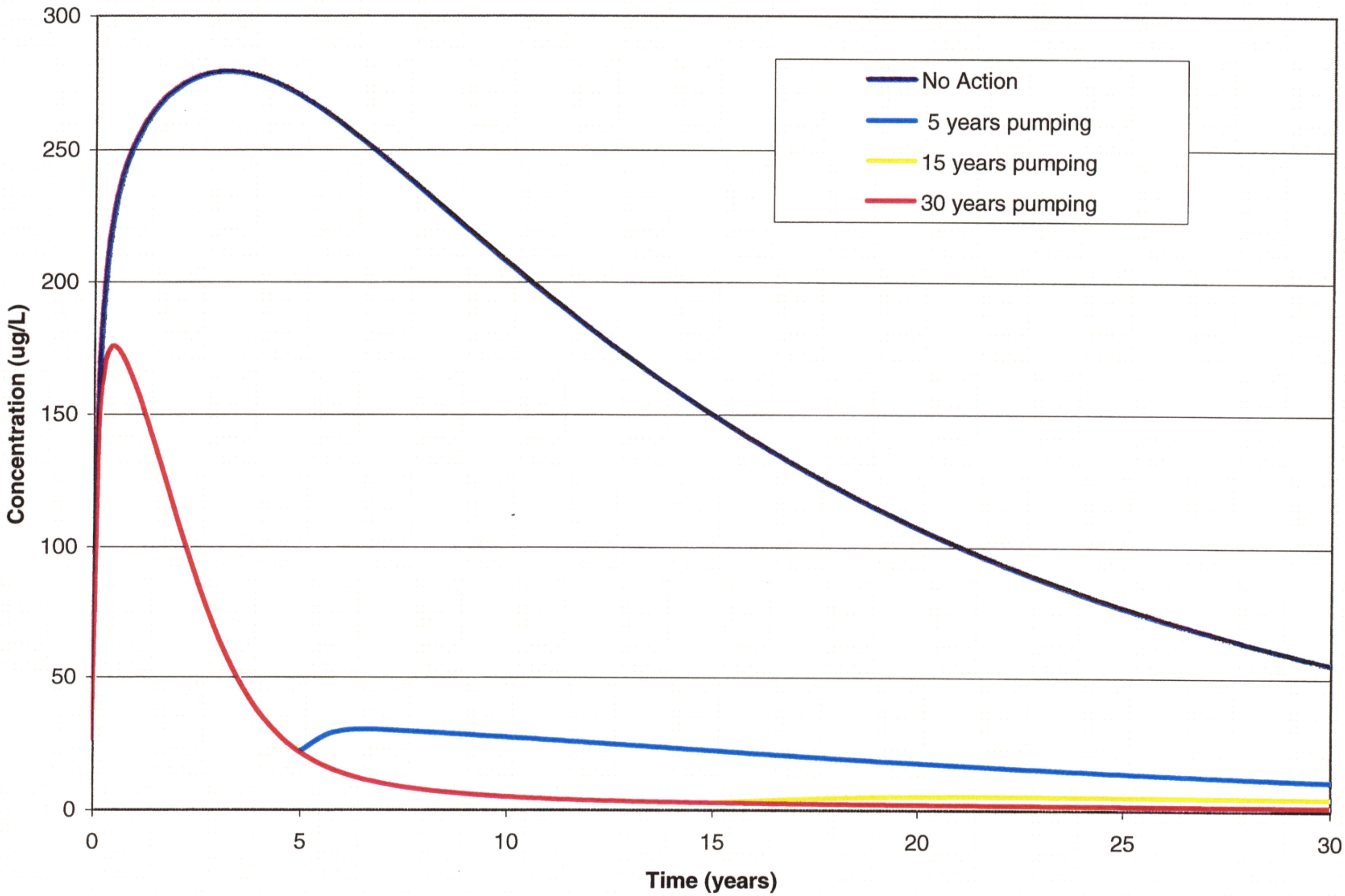


B-17

Figure No. 10
12/02/2002
Revised remedial system with injection wells

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-3\output comparison\comparison.xls- BWD 4-1 (6915)

Bethpage Water District Plant 4-2 (6916)

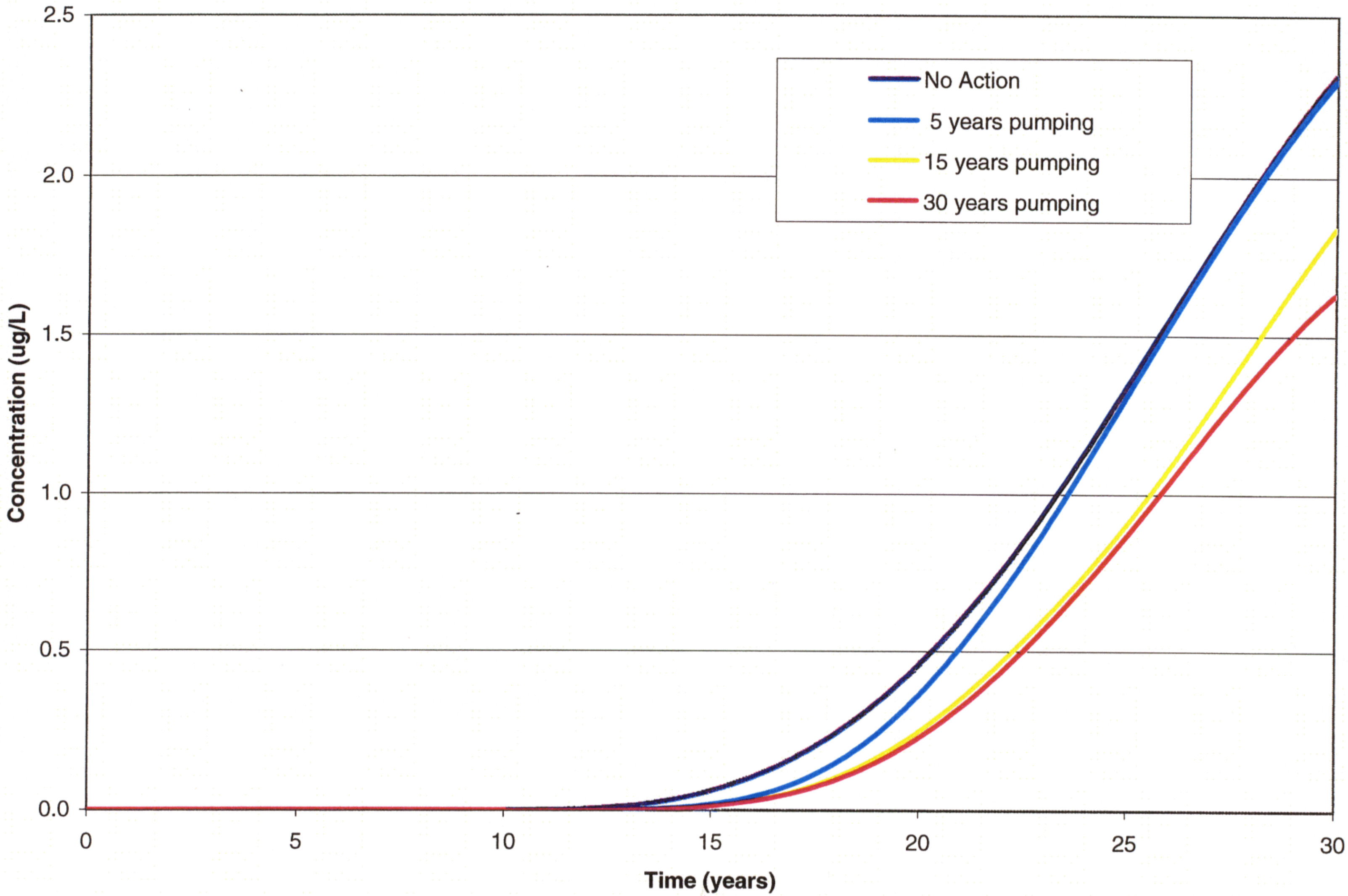


B-18

Figure No. 11
12/02/2002
Revised remedial system with injection wells

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-3\output comparison\comparison.xls- BWD 4-2 (6916)

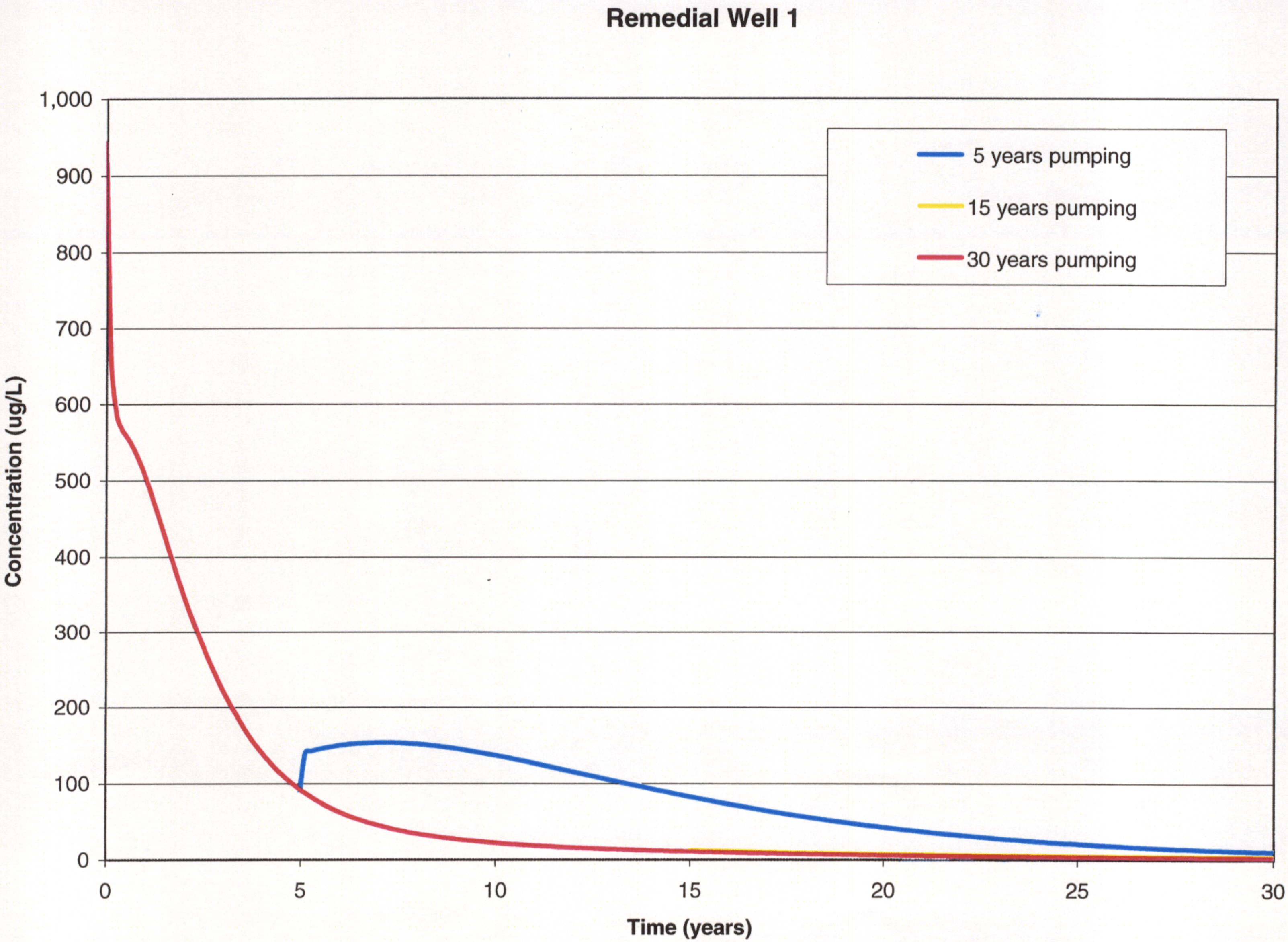
Bethpage Water District Plant 5 (8004)



B-19

Figure No. 12
12/02/2002
Revised remedial system with injection wells

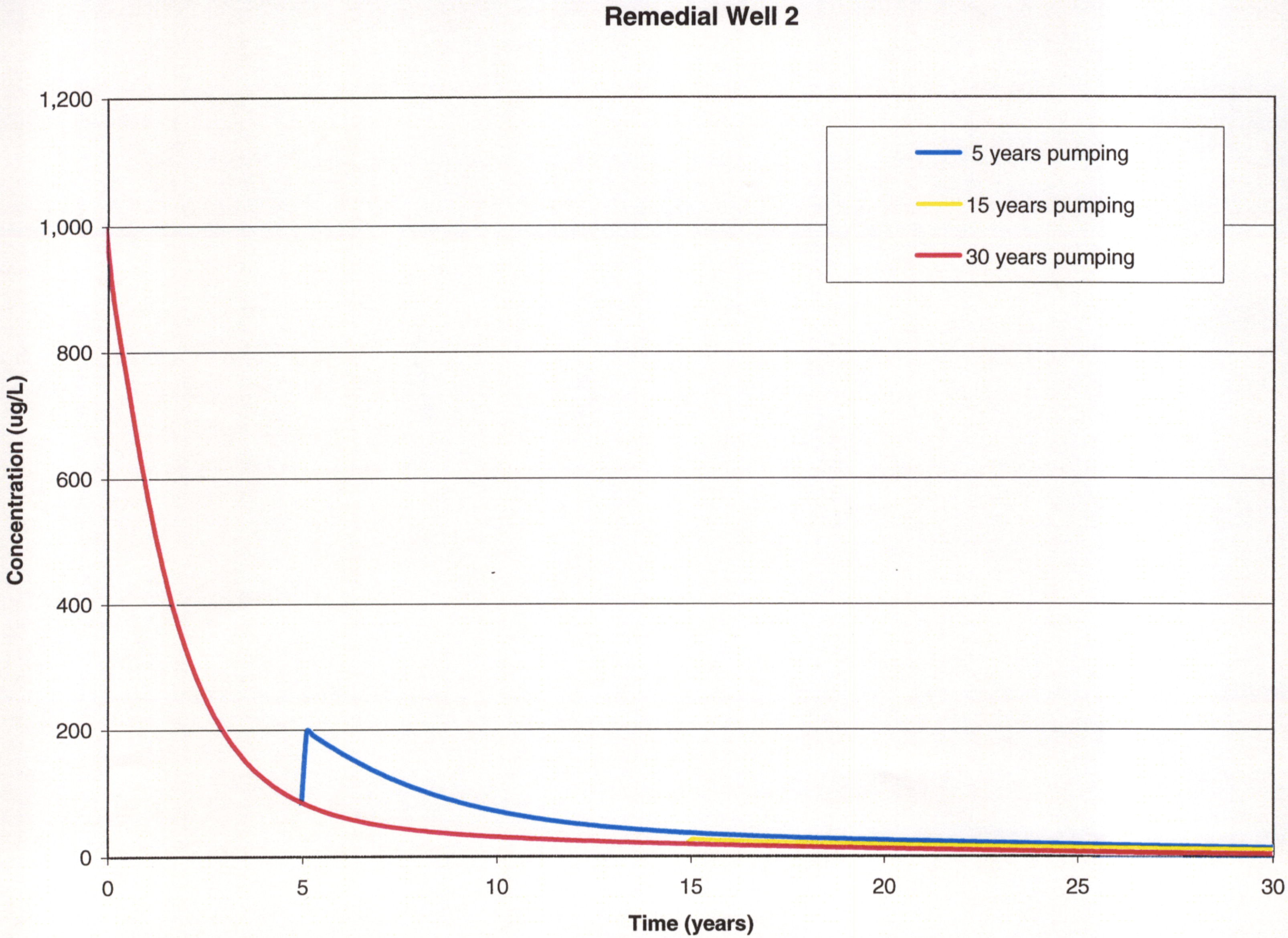
G:\TECHNICL\Porsche\NGModel\GM38-1ppm-3\output comparison\comparison.xls- BWD 5 (8004)



B-20

Figure No. 13
12/02/2002
Originally proposed remedial system (without injection wells)

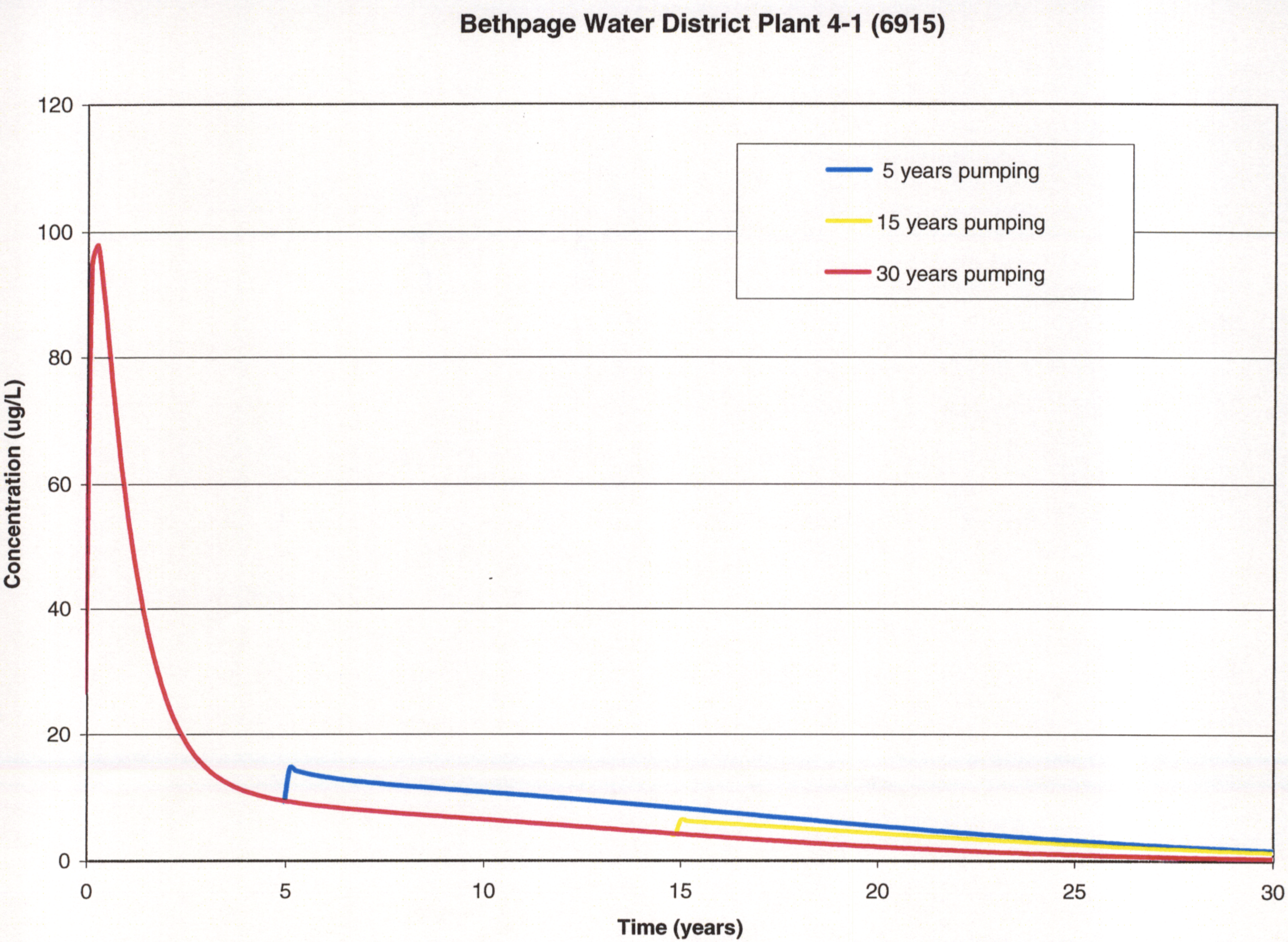
G:\TECHNICL\Porsche\NGModel\GM38-1ppm-2\output comparison\comparison.xls- RW1



B-21

Figure No. 14
12/02/2002
Originally proposed remedial system (without injection wells)

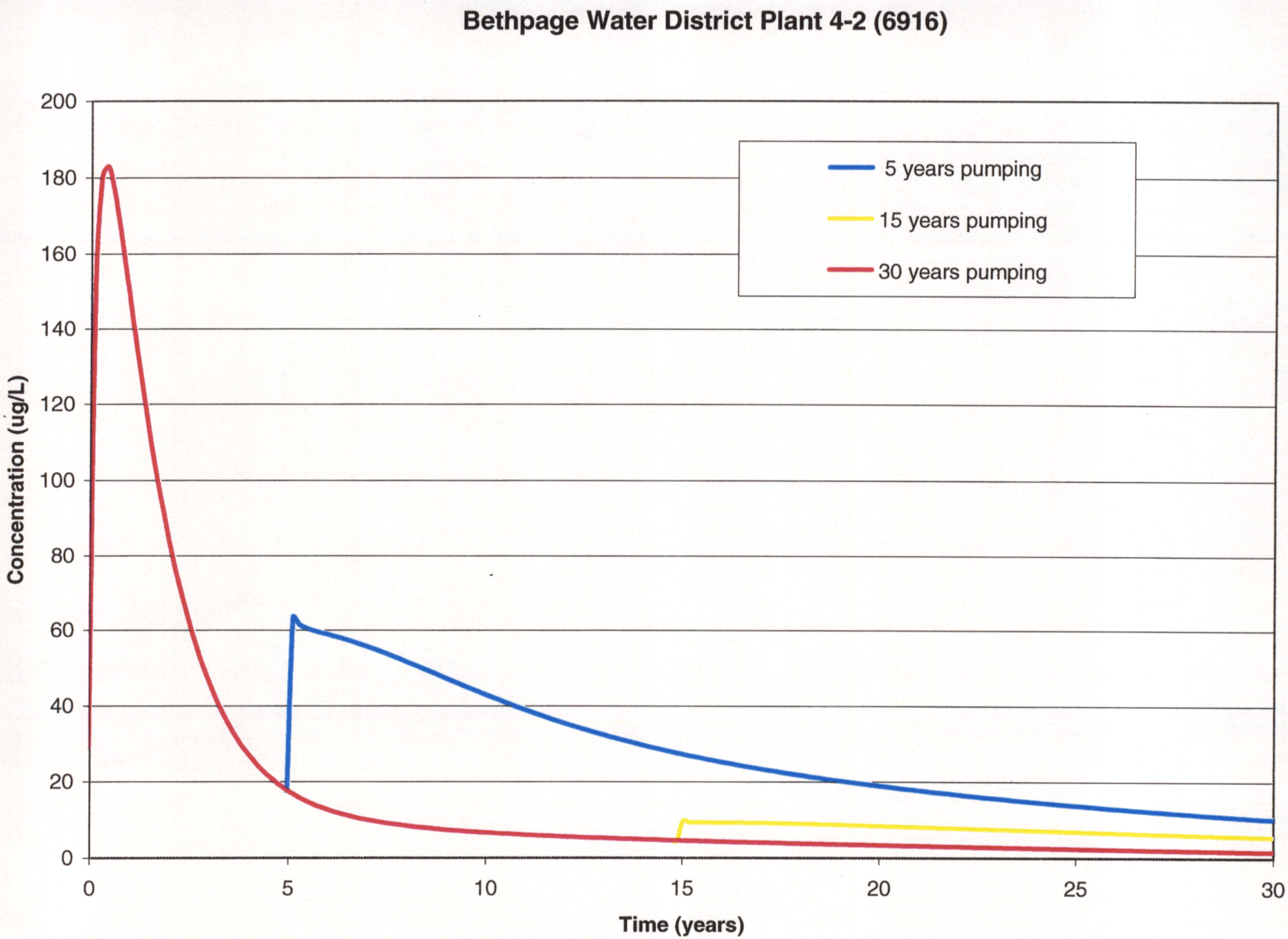
G:\TECHNICL\Porsche\NGModel\GM38-1ppm-2\output comparison\comparison.xls- RW2



B-22

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-2\output comparison\comparison.xls- BWD 4-1 (6915)

Figure No. 15
12/02/2002
Originally proposed remedial system (without injection wells)

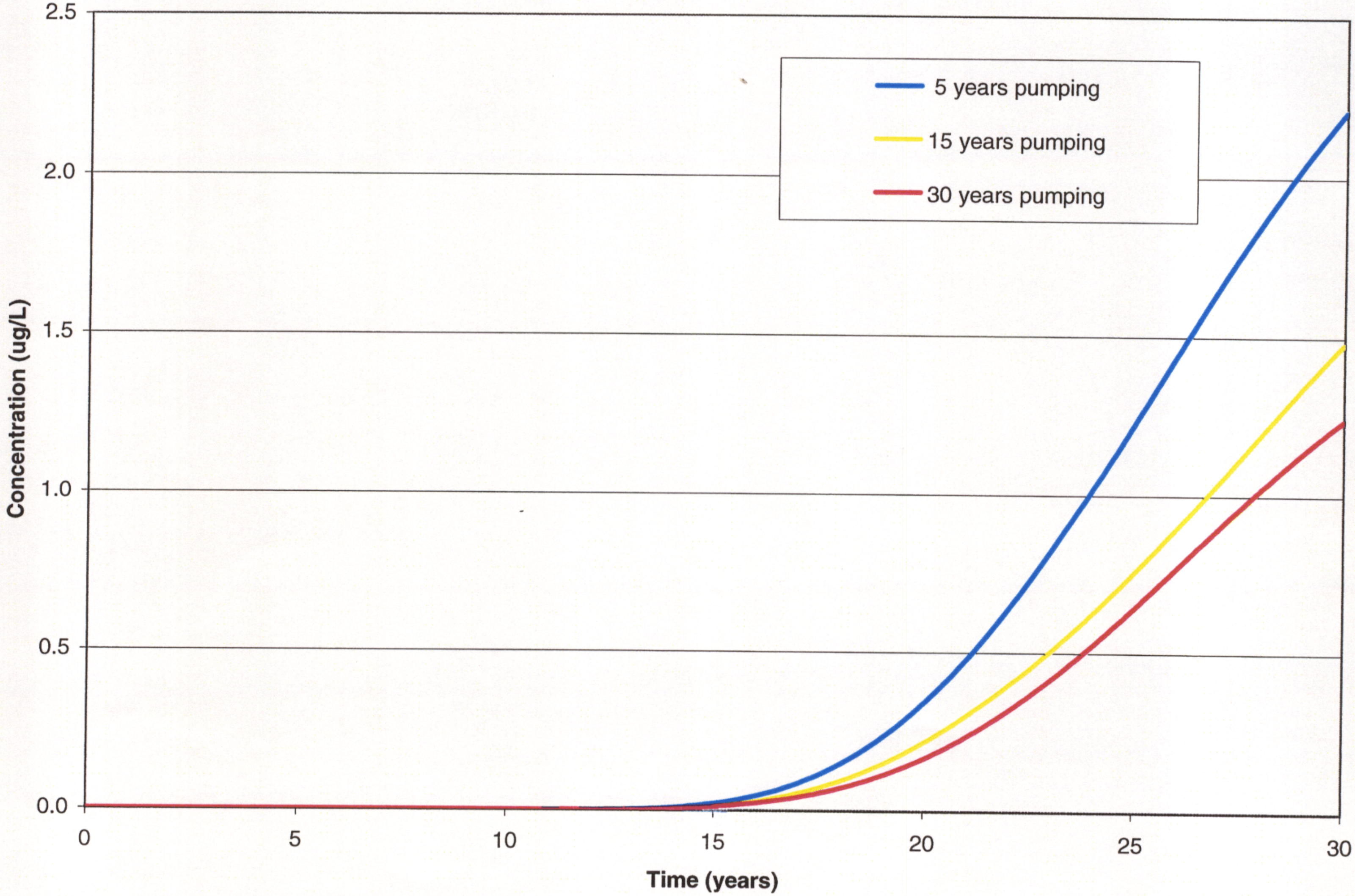


B-23

Figure No. 16
12/02/2002
Originally proposed remedial system (without injection wells)

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-2\output comparison\comparison.xls- BWD 4-2 (6916)

Bethpage Water District Plant 5 (8004)



B-24

G:\TECHNICL\Porsche\NGModel\GM38-1ppm-2\output comparison\comparison.xls- BWD 5 (8004)

Figure No. 17
12/02/2002
Originally proposed remedial system (without injection wells)

APPENDIX C

PROCESS CALCULATIONS

1.0 EXTRACTION/INJECTION WELL CALCULATIONS

1.1 Recovery Well Capture Zone

The capture areas for Recovery Wells 1 and 2 as presented in Figures 3-1, 3-2, and 3-3 of the text are based on the AGM model results presented in Appendix B. These figures present the capture zone areas anticipated to occur within 5 years of operation. This area is expected to coincide with the majority of contamination associated with the GM-38 Area.

To evaluate potential uncertainty with actual GM-38 Area hydrogeological properties, a set of hand calculations was conducted by TtNUS to check the results of the model, as well as conduct a sensitivity analysis of the results by varying key input parameters. The two key input parameters with the highest level of uncertainty that can be evaluated with the existing data are effective aquifer thickness and hydraulic conductivity. Additional uncertainties with actual hydrogeological properties that cannot be quantified at this time are exact localized geological confining units and contaminant distribution. Localized low permeable units can isolate contaminated groundwater from being captured by the recovery wells. Similarly, localized units can allow pockets of clean groundwater to exist within the GM-38 Area that do not require capture by the recovery wells. Long term monitoring will be used to evaluate these issues.

The recovery well capture zone calculations are presented in Attachment C-1.

1.2 Recovery Well Contaminant Concentrations

The estimated maximum concentrations of VOCs that will likely occur in the recovery wells are based on the VOCs measured in the surrounding vertical profile borings (VPBs). Data for Recovery Well screened intervals and vertical profile boring TVOC concentrations are shown schematically on the attached sheets (Attachment C-2) for RW-1 and RW-2. Also presented are individual data points that were used in the calculations.

VPBs and vertical ranges of data used for estimating the concentration of VOCs in the Recovery Wells are summarized as follows.

Recovery Well	Screened Interval (depth ft bgs)	Associated VPB	Estimated Vertical Capture Zone (depth ft bgs)
RW-1	355 to 435	VPB-38 VPB-47 VPB-51	50 to 430
RW-2	440 to 510	VPB-38 VPB-51	340 to 510

ft bgs - feet below ground surface.

1.3 Re-injection Well Calculations

Re-injection Well calculations are presented in Attachment C-3 to this Appendix.

2.0 TREATMENT SCHEME

The treatment scheme would consist of installing and operating an on-site groundwater treatment system for a two-well extraction system. The on-site treatment system would feature the following process units:

- Groundwater Extraction and Conveyance System
- Air Stripper System
- Offgas Treatment System
- GAC Polishing

2.1 GROUNDWATER EXTRACTION SYSTEM

2.1.1 Extraction Wells and Pumping Rate Summary

The depth and flow rate for the extraction system is summarized as follows:

Well Number	Screened Depth (ft bgs)	Extraction Rate (gpm)
RW-1	355-435	800
RW-2	440-510	300
Total		1,100

2.1.2 Extracted Groundwater Quality

Maximum Conditions

Under maximum conditions, it is assumed that the concentration of each COC in the extracted groundwater will be equal to the maximum concentration detected in any of the borings located near the recovery wells, i.e., borings VPB-38, VPB-47, and VPB-51.

COC	Maximum Concentration (µg/L)	Detection Location
Vinyl Chloride	300	VPB-51
1,1-DCE	9	VPB-51
1,1-DCA	4	VPB-51
1,2-DCE	1,100	VPB-51
Chloroform	2	VPB-38
1,2-DCA	3	VPB-38
1,1,1-TCA	3	VPB-38
PCE	900	VPB-51
Chlorobenzene	1	VPB-51
MTBE	2	VPB-38
TCE	3,400	VPB-38
Total VOCs	5,724	

Average Conditions

Under average conditions, it is assumed that the concentration of COCs in the groundwater extracted by each recovery well would be the mathematical average of the concentrations detected in the surrounding borings (VPB-38, VPB-47, and VPB-51 for RW-1; VPB-38 and VPB-51 for RW-2). The overall extracted groundwater quality would be the average of the qualities in each recovery well pro-rated for the extraction rate in that well.

Under average conditions, the anticipated quality of the groundwater extracted by a two-well extraction system is summarized as follows:

COC	RW-1		RW-2		Overall Conc[1] (µg/L)
	Conc (µg/L)	Factor	Conc (µg/L)	Factor	
Vinyl Chloride	6.5	0.73	0.1	0.27	4.8
1,1-DCE	2.0	0.73	0.6	0.27	1.6
1,1-DCA	0.8	0.73	0.3	0.27	0.7
1,2-DCE	41.8	0.73	3.5	0.27	31.5
Chloroform	1.0	0.73	0.4	0.27	0.8
1,2-DCA	1.2	0.73	0.3	0.27	1.0
1,1,1-TCA	4.1	0.73	0	0.27	3.0
Carbon Tetrachloride	0.1	0.73	0	0.27	0.1
1,1,2-TCA	0.3	0.73	0.4	0.27	0.3

COC	RW-1		RW-2		Overall
	Conc (µg/L)	Factor	Conc (µg/L)	Factor	Conc[1] (µg/L)
Benzene	0.1	0.73	0	0.27	0.1
PCE	45.8	0.73	1.3	0.27	33.8
Toluene	1.0	0.73	0	0.27	0.7
Chlorobenzene	0.1	0.73	0	0.27	0.1
Xylenes	0.3	0.73	0	0.27	0.2
MTBE	0.2	0.73	0	0.27	0.1
TCE	461.1	0.73	277.3	0.27	411.5
Total VOCs	566.4	0.73	284.2	0.27	490.2

1. Rounded to the next higher decimal

2.2 AIR STRIPPER SYSTEM

2.2.1 Basis

The existing air stripper column would be re-used with a new air blower sized to provide sufficient discharge pressure to accommodate the new offgas treatment system and achieve a concentration of 0.5 µg/L or less for any VOC in the treated groundwater based upon average extracted groundwater quality.

Groundwater would be treated in the existing packed-tower type air stripper for the removal of VOCs. According to the attached calculations, analysis of this air stripper is summarized as follows:

Groundwater Flow:	1,100 gpm
Groundwater Temperature:	55°F
Total Influent VOCs Concentration:	490 µg/L
Total Effluent VOC Concentration:	0.6 µg/L (see table below for breakdown)
Air-to-Water Ratio (AWR):	50:1
Packing Depth:	25 ft
Packing Type:	3.5-inch Jaeger Tripack
Stripper Column Diameter:	10 ft
Percolation Rate:	14 gpm/ft^2
Stripper Blower Flow:	7,350 cfm
Stripper Blower Discharge Pressure:	18 inches water column
Stripper Blower Motor Size:	30 HP

Under average conditions (i.e., 1,100 gpm groundwater extraction rate and average VOC concentrations), the anticipated performance of the existing air stripping unit is summarized as follows. Calculations are provided in Attachment C-4.

COC	Influent Concentration (µg/L)	Effluent Concentration @50:1 AWR (µg/L)
Vinyl Chloride	4.8	0.0
Cis 1,2-DCE	31.5	0.0
1,2-DCA	1.0	0.1
PCE	33.8	0.0
TCE	411.5	0.5
Total VOCs	490.2	0.6

Use for one (1) horizontal-centrifugal 1,100 gpm treated groundwater discharge pump (60 ft TDH, 25 HP motor). Note that the pump rate capacity will be increased by 100 gpm to incorporate a recycle loop.

2.2.2 Performance Under Maximum Conditions

Under maximum conditions (i.e., 1,100 gpm groundwater extraction rate and maximum VOCs concentrations), the anticipated performance of the existing air stripping unit is summarized as follows, (See Attachment C-4 for calculations):

COC	Influent Concentration (µg/L)	Effluent Concentration @50:1 AWR(1) (µg/L)
Vinyl Chloride	300	0.0
Cis 1,2-DCE	1,100	1.3
1,2-DCA	3	0.3
PCE	900	0.9
TCE	3,400	4.5
Total VOCs	5,724	7.0

2.3 OFFGAS TREATMENT SYSTEM

Air stripper offgas is treated by vapor-phase granular activated carbon (GAC) adsorption to remove VOCs.

The sizing of the offgas treatment system is based upon average conditions for the extracted groundwater quality. Higher concentrations of VOCs in the extracted groundwater would result in more frequent carbon change out, but would not affect the treated offgas quality.

2.3.1 Air Dryer

The humidity of the air stripper off gas needs to be reduced from 100% to 50% by an electric air dryer to optimize the effectiveness of the vapor-phase GAC adsorption process.

Weight of air be dried: 7,350 cfm air x 0.075 lbs/ft^3 air = 551 lbs air/min
As per Perry's Handbook Figure 12-1 (50th Edition, page 12-4), power needed to dry 60 °F air from saturation to 50% is approximately 6 BTU/lb air.
Required Power: 551 lbs air/min x 6 BTU/lb air x 0.01757 Kw/BTU/min = 58 Kw

Use a 75 Kw electrical air dryer to handle potentially higher future air flow rates.

2.3.2 Vapor-Phase GAC Adsorption

The vapor-phase GAC adsorption unit is sized based upon a rate of 50 cfm/ft^2 of bed surface area and a bed depth of 3 ft.

GAC bed surface area: 7,350 cfm ÷ 50 cfm/ft^2 = 147 ft^2
GAC bed volume: 147 ft^2 x 3 ft = 441 ft^3
@ 30 lbs/ft^3 GAC bulk density, GAC weight: 441 ft^3 x 30 lbs/ft^3 = 13,230 say 13,600 lbs

Estimated weights of main VOCs in stripper offgas:

Vinyl Chloride: 1,100 gpm x 1,440 min/day x 8.34 lbs/gal x 4.8 µg/L x 10^{-9} = 0.06 lbs/day
1,2-DCE: 1,100 gpm x 1,440 min/day x 8.34 lbs/gal x 31.5 µg/L x 10^{-9} = 0.42 lbs/day
PCE: 1,100 gpm x 1,440 min/day x 8.34 lbs/gal x 33.7 µg/L x 10^{-9} = 0.45 lbs/day
TCE: 1,100 gpm x 1,440 min/day x 8.34 lbs/gal x 411.0 µg/L x 10^{-9} = 5.43 lbs/day

Estimated GAC consumption:

For Vinyl chloride removal: 0.06 lbs/day x 150 lbs GAC/lb VC = 9.0 lbs/day
For 1,2-DCE removal: 0.42 lbs/day x 10 lbs GAC/lb 1,2-DCE = 4.2 lbs/day
For PCE removal: 0.45 lbs/day x 3 lbs GAC/lb PCE = 1.3 lbs/day
For TCE removal: 5.43 lbs/day x 6 lbs GAC/lb TCE = 32.6 lbs/day

Total estimated GAC consumption: 9.0 + 4.2 + 1.3 + 32.6 = 47.1 lbs/day

Frequency of GAC adsorption unit replacement: 13,600 lbs ÷ 47.1 lbs/day = 289 days, say every 9 months

Use a vapor-phase GAC adsorption system consisting of one (1) adsorption unit holding 13,600 lbs GAC (Carbonair Model GPC 120, or equivalent).
Provide a second vapor-phase GAC adsorption unit holding 13,600 lbs GAC during startup and periods with higher than normal emissions of VOCs.

Because of the pressure drop associated with the second GAC unit, provide a second blower. Size the second blower to be identical to the first blower. With only one vapor phase unit in line, either fan can provide the total air flow for the system, or both units can be used to increase the air flow rate system and therefore accommodate higher groundwater extraction rates.

2.4 GAC POLISHING TREATMENT SYSTEM

The treated groundwater effluent from the air stripper column will be polished with liquid-phase granular activated carbon (GAC) adsorptions units to remove residual VOCs. Under normal operating conditions, the liquid-phase GAC adsorbers will not significantly effect the quality of the groundwater. Non-detectable concentrations of VOCs are anticipated for the groundwater entering and exiting the adsorbers. Theoretically, trace amounts of organics may be removed in the column.

Estimate GAC frequency change out assuming that 0.5 ug/l of TCE are adsorbed onto the liquid phase GAC.

TCE: 1,100 gpm x 1,440 min/day x 8.34 lbs/gal x 0.5 µg/L x 10^{-9} = 0.007 lbs/day
Estimated GAC consumption: 0.007 lbs/day x 1000 lbs GAC/lb TCE = 7 lbs/day
Frequency of GAC adsorption unit replacement (large unit with 20,000 pounds GAC):

20,000 ÷ 7 lbs/day = 2,857 days, or 8 years.

Based on the absence of measurable organic loading to the units, the change out frequency for the GAC units will not likely be based on organic loadings.

If suspended solids form in the air stripper column and/or if solids are present in the extracted groundwater, then GAC adsorbers may act as a filter and trap a portion of the solids. In addition, biological growth may occur within the units. The accumulation of these materials in the adsorber will increase the pressure drop across the units over time and ultimately require action to maintain system flow.

Excessive pressure drop across the adsorbers can be addressed by partial or complete carbon change out. Partial carbon change out would involve removing the upper portion of GAC from each of the units (approximately upper 25%), which is where most solids would accumulate. Backwash provisions are not considered in this analysis because of extensive costs and space associated with auxiliary equipment.

The liquid phase carbon units will be sized based on hydraulic properties. Normal hydraulic requirements include:

Hydraulic unit rates: 4 to 8 gallons per minute per square foot (gpm/sf)
Empty bed contact time: 7.5 to 15 minutes.

For 1,100 gpm of flow, at 4 gpm/sf, a surface area of 275 sf is required.

Each 10 foot diameter adsorber has a surface area of 78 sf. Therefore, provide 3.5 or:

Four (4) 10-diameter adsorber.

A typical 10-foot diameter adsorber contains 20,000 pounds of GAC. At a GAC bulk density of 28 pounds per cubic foot (cf), the adsorber has an empty bed volume of 714 cubic feet or 5,300 gallons. At the system flow rate of 1,100 gpm, the GAC polishing system with four adsorbers has an empty bed contact time of 19 minutes, which is adequate.

The estimated initial pressure drop across these units at the system flow rate is approximately 2 to 3 psi (5 to 7 feet water-head).
Four 10-foot diameter adsorbers would have a maximum hydraulic rate of approximately 2600 gpm.

Alternatively, two 12-foot diameter (20,000 pound) GAC units can be used. The corresponding hydraulic rate and empty bed contact time would be 5 gpm/sf and 10 minutes, respectively. The maximum hydraulic rate with two 12-diameter units would be approximately 1400 gpm.

3.0 AIR PERMIT EVALUATION

3.1 ANTICIPATED STRIPPER COLUMN OFFGAS

The anticipated concentrations and mass loadings of the various chemicals of concern (COCs) in the offsite GM38 Area extracted groundwater and offgas of the proposed air stripping unit is summarized as follows:

COCs	SGC(1) (μg/m³)	AGC(1) (μg/m³)	Groundwater Conc. (2) (μg/L)	Offgas Conc.(3) (μg/m³)	Mass Loading(4)		
					lbs/hr	lbs/day	lbs/year
VC	1,300	0.02	4.8	91	0.0025	0.06	21.9
1,2-DCE	190,000	1,900	31.5	635	0.0175	0.42	153.3
PCE	81,000	0.075	33.8	676	0.0187	0.45	164.2
TCE	33,000	0.45	411.5	8,229	0.2267	5.44	1985.6

(1) Short-term Guideline Concentrations (SGC) and Annual Guideline Concentrations (AGC), as established in the New York State Department of Environmental Conservation (NYSDEC) Guidelines For the Control of Toxic Ambient Air Contaminants (1991)
(2) Average of detected concentrations pro-rated for an extraction rate of 800 gpm from Recovery Well (RW) 1 and 300 gpm from RW-2
(3) Based upon an estimated 100% volatilization of groundwater COCs and an air stripping flow rate of 7,350 cfm
(4) Based upon a groundwater extraction flow of 1,100 gpm

Based upon the above data, it can be seen that although none of the estimated air stripping offgas concentrations of COCs are anticipated to exceed the SGC values. However, estimated offgas concentrations of VC, PCE, and TCE are anticipated to be greater than the AGC values, triggering the need for an ambient air quality impact assessment, as mandated by NYSDEC in their Guidelines For the Control of Toxic Ambient Air Contaminants. Use Standard Point Source Method, as amended by NYSDEC in October 16, 1995 for this assessment.

3.2 POINT SOURCE METHOD

The point source method consists of a basic cavity impact method to evaluate potential localized effects near buildings, followed by a point source analysis to evaluate potential effects at a distance.

3.2.1 Basic Cavity Impact Method

Because buildings can cause stack discharges to be drawn to ground level through localized eddies, the building cavity distance must be determined to evaluate where these effects may occur.

Determine if building cavity is located on the targeted property.

Building height is assumed to be 30 feet.
Horizontal extent of cavity = 3 x building height = 3 x 30 = 90 feet.

Note: Private property is located a minimum of 100 feet from the planned building location. However, a fence may be required to restrict periodic (recreational) access to areas near the building.

3.2.2 Standard Point Source Method

Because of the residential setting, stack height is assumed to be 40 feet and the building height is assumed to be 30 feet. The ratio of stack height to building height is less than a GEP stack.

Therefore, in accordance with III.A.1.a, assume that no plume rise exists.

Calculate the Annual Impact. Because the GM-38 Remedy is assumed to operate continuously during the course of a year (8750 hours per year), the potential annual impact will equal the actual annual impact estimate. Therefore, calculate only the potential annual impact impact.

For each COC, the maximum Potential Annual Impact, C_p in μg/m^3, is estimated according to the following formula:

$$C_p = (52{,}500 \times Q) \div h_e^{2.25}$$

where:

Q: mass loading of COC in lbs/hr
h_e: effective stack height in feet = h_a = 40 feet

Therefore:

C_p for VC = (52,500 x 0.0025 lbs/hr) ÷ $40^{2.25}$ = 0.03 μg/m^3
C_p for 1,2-DCE = (52,500 x 0.0175 lbs/hr) ÷ $40^{2.25}$ = 0.23 μg/m^3
C_p for PCE = (52,500 x 0.0187 lbs/hr) ÷ $40^{2.25}$ = 0.24 μg/m^3
C_p for TCE = (52,500 x 0.2267 lbs/hr) ÷ $40^{2.25}$ = 2.96 μg/m^3

All of the above C_p, except that for 1,2-DCE, exceed the AGC values. Therefore, offgas treatment will be required to remove VC, PCE, and TCE.

Required removal of VC = (0.03 – 0.02) ÷ 0.03 = 33%
Required removal of PCE = (0.24 – 0.075) ÷ 0.24 = 69%
Required removal of TCE = (2.96 – 0.45) ÷ 2.96 = 85%

Calculated VOC concentrations in the air stripper column influent at the system flow rate, in which vapor phase treatment may not be required.

Vinyl chloride: 4.8 ug/l (water conc.) x 0.02 ug/m^3 / 0.03 ug/m^3 = 3.2 ug/l (stripper influent conc.)
PCE: 33.8 ug/l (water conc.) x 0.075 ug/m^3 / 0.24 ug/m^3 = 11 ug/l (stripper influent conc.)
TCE: 411 ug/l (water conc.) x 0.45 ug/m^3 / 2.96 ug/m^3 = 62 ug/l (stripper influent conc.)

Note: Vinyl chloride was only detected in one sample at a significant concentration. Because of the distance (600 feet), the presence of aerobic aquifer zones located between the area where VC was detected and the extraction wells resulting in natural degradation, VC may not enter the GM-38 treatment system. If VC enters the extraction wells at unacceptably high concentrations, then alternative off gas treatment, more frequent GAC changeout, and/or alternative discharge limits may be required. Groundwater monitoring wells will be used to track potential vinyl chloride migration.

The Air Guide values are relatively conservative. Detailed air modeling should be conducted to determine the need the treatment and alternative discharge criteria.

4.0 GROUNDWATER AGGRESIVITY (CORROSIVITY)

4.1 Equilibrium pH Calculation

Estimated groundwater quality

Parameter	Design Value[1]
Calcium (mg/L Ca)	4.5
Alkalinity (mg/L $CaCO_3$)	3.5 (assumed)
Total Dissolved Solids (TDS) (mg/L)	56
Temperature (°F)	60
pH (S.U.)	5.5

[1] As measured in monitoring well GM-38D

Based upon the above groundwater quality and as illustrated on the attached Nalco Aquagraph, the equilibrium PH (pHs) for the groundwater is 10.6.

4.2 Langelier Index

The Langelier Index (LI) can be determined according to the following formula:

LI = 2 pHs – pHa

For the offsite GM38 Area groundwater;

LI = (2 x 10.6) – 5.5 = 15.7

Typically an LI of less than 6.0 indicates that the groundwater has a scaling tendency and an LI of more than 6.0 indicates that the groundwater has an aggressive (or corrosive) tendency. An LI of 15.7 indicates a severe aggressive tendency that must be taken into consideration for the selection of materials of fabrication.

4.3 pH CONTROL

The measured pH of 5.5 corresponds to an hydrogen ion concentration ($[H^+]$) of $10^{-5.5}$, or 0.0000032 mole/liter.

Therefore, depending on the level of buffering present in the groundwater water, neutralization of this acidity will require addition of a minimum of
0.0000032 moles/liter of hydroxyl ion ($[OH^-]$) to effect the following reaction:

$$[H^+] + [OH^-] \rightarrow H_2O$$

Caustic soda (or sodium hydroxide NaOH), which has a molecular weight of 40 grams is typically used for this purpose and the following concentration would be required:

40,000 mg/mole x 0.0000032 moles/liter = 0.13 mg/L

Although the offsite GM38 Area groundwater has very little buffering, it is assumed that at least 0.5 mg/L of caustic soda will have to be used to take into account the partial inefficiency of the neutralization reaction.

On that basis, it is assumed that the following amount of 50% caustic soda solution will be needed on a daily basis for neutralization:

1,100 gpm x 1,440 min/day x 8.34 lbs/gal H_2O x 0.5 mg/L NaOH x 10^{-6} ÷ 6.25 lbs NaOH/gal 50% sol
= 1.1 gallons per day

13c/14

INSTRUCTIONS

To find Aquapoise (pHs) or Stability Index of any water:

1. For reading in parts per million use only figures on red. For grains per gallon, use figures on white.
2. Set total alkalinity figure on large disc opposite calcium figure on card.
3. Set temperature figure on top disc opposite dissolved solids figure on large disc.
4. Read Aquapoise, pHs, opposite pointer.
5. To obtain Stability Index multiply Aquapoise (pHs) value by 2 and subtract actual pH value (Stability Index = 2pHs − pH). Above a Stability Index value of 6, the water has corrosive tendencies. Below 6, the water will have scaling tendency.

NALCO CHEMICAL COMPANY

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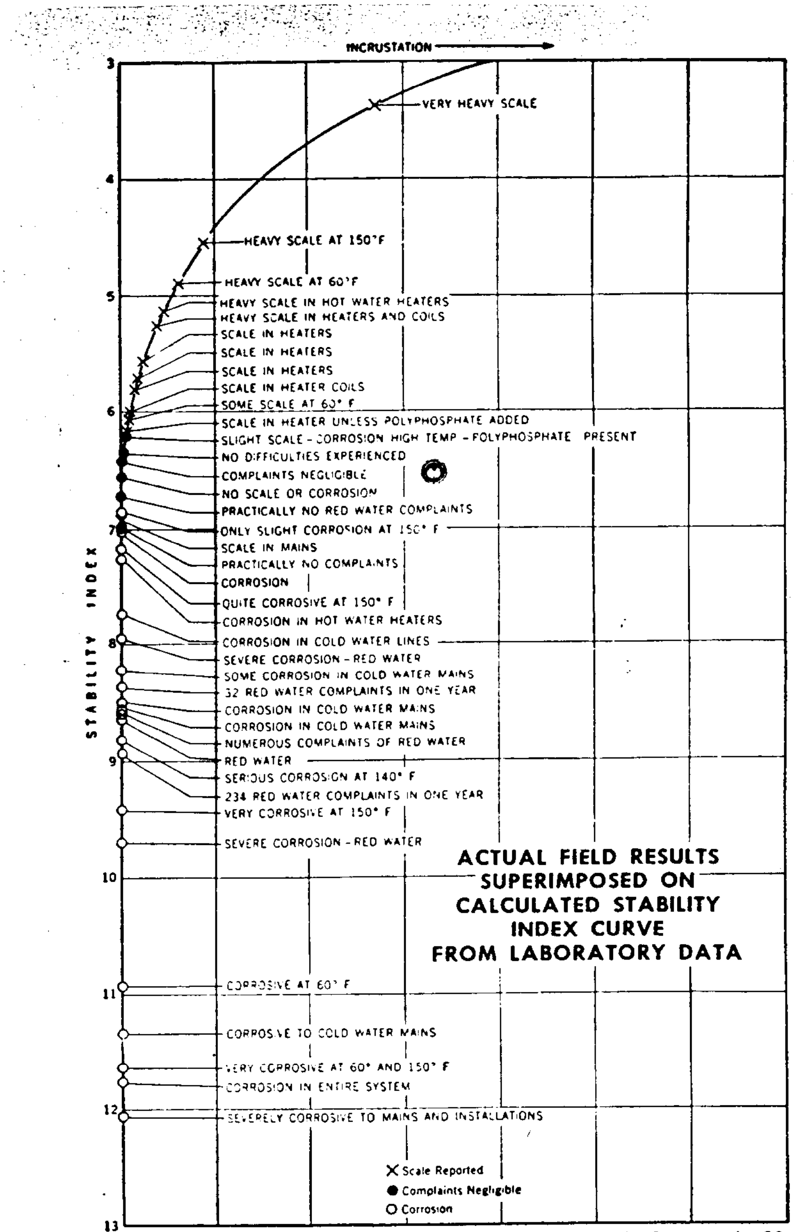

A complete discussion of Stability Index appears in Nalco Reprint Summary No. 20. For information on stabilization chemicals please see your Nalco representative.

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Attachment C-1
Recovery Well Capture Zone Calculations

CAPTURE ZONE PROJECTIONS
NWIRP BETHPAGE, NEW YORK
February 2003

Calculations were performed to estimate the steady-state lateral, upgradient, and downgradient capture zone geometries for the two extraction wells planned for the GM 38 area. The target total extraction rate for these two wells is 1,100 gpm. Extraction well RW-1 has a preliminary target extraction (pumping) rate of 800 gpm, while RW-2 is a deeper well with a preliminary target extraction rate of 300 gpm. Based on geologic cross section information developed using limited geophysical and boring log data, RW-1 appears to be positioned in an area where the vertical distance between overlying and underlying aquitards is approximately 300 feet. In the local area around the screened interval of RW-2, there appear to be overlying and underlying aquitards separated by a distance of approximately 100 feet. Other major inputs/assumptions into the baseline steady-state capture zone calculations include:

- The background groundwater flow gradient is 0.0022 (from groundwater flow modeling).
- The hydraulic conductivity of the aquifer sediments averages 25 ft/day throughout the portions of the aquifer that the extraction wells draw from, based on Arcadis/Geraghty and Miller model input information.
- The potential effects of overlapping capture zones and recharge wells were ignored for this evaluation.

Additional sets of calculations were performed to address key uncertainties identified. One uncertainty is in regards to the thicknesses of the portions of the aquifer that will contribute water to each of the extraction wells. The continuity and hydraulic properties of the local confining units that are assumed to act as upper and lower boundaries for the pumping wells are not well defined, therefore additional capture zone projections were performed using aquifer thicknesses of 450 ft for RW-1 (1.5x the apparent aquifer thickness for this well) and 200 ft for RW-2 (2x the apparent aquifer thickness for this well). There is also some uncertainty regarding the most appropriate hydraulic conductivity value to use as an overall average for capture zone calculations. As indicated above, the hydraulic conductivity assigned by Arcadis/Geraghty and Miller during their modeling efforts for the portions of the aquifer greater than 100 feet below the water table is 25 ft/day. In their October 1997 Groundwater Flow Model Report for Northrop Grumman Corporation, however, Geraghty and Miller presented a hydraulic conductivity range for the middle Magothy aquifer of 30-70 ft/day. Halliburton NUS Corporation performed two pumping tests as part of a Phase II Remedial Investigation at NWIRP Bethpage, with the pumping test analyses indicating an overall average hydraulic conductivity of about 100 ft/day for the Upper Glacial and Magothy aquifers (Phase 2 Remedial Investigation Report, Halliburton NUS, 1993). The scenarios described above in regards to the pumping rates and assumed aquifer thicknesses were run using assumed average hydraulic conductivities of 25, 50, and 100 ft/day, to address uncertainties regarding the actual representative hydraulic conductivity for the aquifer. These additional calculations provide a conservative range of capture zone geometries for use in projecting the extraction system performance.

Table 1 presents the steady-state capture zone calculations for the various assumed aquifer thicknesses and average hydraulic conductivities of 25, 50, and 100 ft/day. Both variables that were changed (aquifer thickness, hydraulic conductivity) affect the capture zones linearly, i.e. doubling the aquifer thickness decreases the capture zone by ½ and doubling the hydraulic conductivity decreases the capture zone by ½. Because of this linear relationship, the largest calculated steady-state capture zones were for the scenarios run using a hydraulic conductivity of 25 ft/day and the smaller assumed aquifer thicknesses, while the smallest capture zones correspond the scenarios run using a hydraulic conductivity of 100 ft/day and the larger aquifer thicknesses.

Based on the pumping rate combination of 800 gpm for RW-1 and 300 gpm for RW-2, the steady-state capture zone for RW-1 is slightly smaller than to slightly larger than the capture zone for RW-2, depending on the aquifer thicknesses used. In general, the pumping rates of 800 and 300 gpm for RW-1 and RW-2 respectively appear to be reasonably well balanced in terms of capture zones. Some flexibility should be built into the actual pumping systems, however, to allow for adjustment of rates based on the actual field conditions encountered.

The calculated steady-state capture zone limits were compared to the capture zones predicted by Arcadis/Geraghty and Miller through their modeling work. Based on the groundwater flow model, RW-1 is predicted to have a lateral capture zone extent at the well of approximately 1,900 feet and a downgradient capture zone limit of approximately 800 feet, based on a pumping rate of 800 gpm. RW-2 is predicted to have a lateral capture zone extent at the well of approximately 2,000 feet and a downgradient capture zone limit of approximately 850 feet, based on a pumping rate of 300 gpm. The calculated capture zones in Table 1 for RW-1 and RW-2, based on an assumed hydraulic conductivity of 25 ft day, are approximately 25% to 100+% higher than the model-predicted capture zones. The capture zones calculated for RW-1 and RW-2 based on an average hydraulic conductivity of 50 ft/day are slightly greater than to significantly less than the model-predicted capture zones, depending on the aquifer thickness assumed. The capture zones calculated for RW-1 and RW-2 based on an average hydraulic conductivity of 100 ft/day are significantly less than the model-predicted capture zones, and may not encompass the estimated area with 500 ug/L or greater total VOCs.

The calculated steady-state capture zone geometries are based on limited data and should be considered approximations only. In addition, the presence of operating municipal water supply wells in the area and the potential future use of injection wells were not factored in to the capture zone delineations as they were with the numerical groundwater flow model. These wells will impact the extraction well capture zone configurations by locally changing the groundwater flow field (municipal wells would act as groundwater sinks, in some cases competing with the extraction wells for water; recharge wells would act to divert flow around them and may provide water to nearby pumping wells, thus decreasing the well's capture zone extent). The actual capture zones for the extraction wells should be determined through hydraulic testing of the extraction wells after installation.

Table 1
Capture Zone Calculations
NWIRP Bethpage, New York

K = 25 ft/day

Well	K, ft/day	b, ft	i	Q, gpm	Q, ft3/day	Capture Zone Widths, ft		
						Maximum	At well	Downgradient
RW-1	25	300	0.0022	800	154008	9334	4667	1486
	25	450	0.0022	800	154008	6223	3111	990
RW-2	25	100	0.0022	300	57753	10501	5250	1671
	25	200	0.0022	300	57753	5250	2625	836

K = 50 ft/day

Well	K, ft/day	b, ft	i	Q, gpm	Q, ft3/day	Capture Zone Widths, ft		
						Maximum	At well	Downgradient
RW-1	50	300	0.0022	800	154008	4667	2333	743
	50	450	0.0022	800	154008	3111	1556	495
RW-2	50	100	0.0022	300	57753	5250	2625	836
	50	200	0.0022	300	57753	2625	1313	418

K = 100 ft/day

Well	K, ft/day	b, ft	i	Q, gpm	Q, ft3/day	Capture Zone Widths, ft		
						Maximum	At well	Downgradient
RW-1	100	300	0.0022	800	154008	2333	1167	371
	100	450	0.0022	800	154008	1556	778	248
RW-2	100	100	0.0022	300	57753	2625	1313	418
	100	200	0.0022	300	57753	1313	656	209

K = hydraulic conductivity
b = aquifer thickness
i = groundwater flow gradient
Q = recovery well pumping rate

Attachment C-2
Recovery Well Contaminant Concentration Calculations

ESTIMATED TVOC CONCENTRATIONS IN RW-1
TABLE 1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-47 (400 ft South) Total VOCs (µg/L)		RW-1 (µg/L)		VPB-51 (570 ft North-Northeast) Total VOCs (µg/L)	VPB-38 (710 ft West-Northwest) Total VOCs (µg/L)
45	50	8				2	21 27
25	70	NA				NA	NA
5	90	NA				NA	NA
-5	100	NA				2	37
-15	110	NA				NA	NA
-25	120	NA				NA	NA
-35	130	0				NA	NA
-55	150	1				2	4
-75	170	NA				NA	NA
-85	190	NA				NA	NA
-105	200	NA				173	NA
-115	210	0				NA	NA
-125	220	12				881	0
-135	230	NA				NA	NA
-145	240	40				3144	169
-155	250	NA				NA	3420
-165	260	182				24	2337
-175	270	NA				NA	2132
-185	280	181				4	2231
-195	290	NA				NA	1130 1129
-205	300	280				381	620
-215	310	NA				NA	289
-225	320	NA				242	591
-235	330	NA				NA	1006
-245	340	716				34	729
-255	350	NA				NA	1308
-260	355	NA				NA	NA
-265	360	NA				7	NA
-275	370	NA				NA	NA
-285	380	185				6	507
-295	390	NA				NA	566
-305	400	945				11	586
-315	410	NA				NA	NA
-325	420	20				1	NA
-335	430	NA				NA	1
-340	435	NA		532.48		NA	NA
-345	440	NA				3	NA
-355	450	NA				NA	875 862
-365	460	NA				49	566
-375	470	NA				NA	526
-385	480	118				0	NA
-395	490	NA				NA	122
-405	500	NA				NA	NA
-415	510	NA				38	2
-425	520	NA				0	NA
-435	530	0				NA	0
-445	540	10				29	12
-455	550	NA				NA	NA
-465	560	10				17	0
-470	565	NA				NA	NA
-475	570	NA				NA	4
-485	580	NA				12	NA
-490	585	NA				NA	NA
-495	590	0				NA	NA
-505	600	0				3	NA
-515	610	NA				NA	NA
-525	620	0				0	1
-535	630	NA				NA	NA
-545	640	NA				0	NA
-555	650	NA				NA	NA
-565	660	NA				NA	NA
-575	670	2				NA	0
-585	680	2				NA	NA
-595	690	NA				NA	NA
-605	700	1				2	NA
-615	710	NA				NA	NA
-625	720	0				3	NA
-635	730	NA				NA	NA
-645	740	378				NA	NA
-655	750	NA				NA	NA
-665	760	NA				NA	NA
-675	770	NA				NA	NA
-685	780	NA				NA	NA
-695	790	NA				NA	NA
-705	800	NA				NA	NA

Note: Ground surface elevation assumed to be constant as 95' above mean sea level.
NA = Not Analyzed
Bold = Concentration exceeds 500 µg/L.

AVERAGE CONCENTRATIONS OF SPECIFIC CHEMICALS AT RW-1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47	VPB-47
Elevation (msl)	45	-55	-125	-145	-165	-185	-205	-245	-285	-305	-325
Depth (bgs)	50	150	220	240	260	280	300	340	380	400	420
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	0	0	0	1	0	0	0
1,1 Dichloroethene	0	0	0	0	0	0	0	4	1	2	0
1,1 Dichloroethane	8	0	1	1	0	0	0	4	0	2	0
1,2 Dichloroethene	0	0	6	9	0	0	0	460	60	170	2
Chloroform	0	0	0	1	2	1	0	0	1	0	0
1,2 Dichloroethane	0	0	0	0	0	0	0	0	0	0	0
1,1,1 Trichloroethane	0	1	0	0	0	0	0	0	0	0	0
Carbon Tetrachloride	0	0	0	0	0	0	0	0	0	1	0
1,1,2 Trichloroethane	0	0	0	0	0	0	0	0	0	0	0
Benzene	0	0	0	0	0	0	0	0	0	0	0
Tetrachloroethene	0	0	0	1	0	0	0	7	3	0	0
Toluene	0	0	0	0	0	0	0	0	0	0	0
Chlorobenzene	0	0	0	0	0	0	0	0	0	0	0
Ethyl Benzene	0	0	0	0	0	0	0	0	0	0	0
o Xylene	0	0	0	0	0	0	0	0	0	0	0
m + p Xylene	0	0	0	0	0	0	0	0	0	0	0
ter.ButylMethylEther	0	0	0	0	0	0	0	0	0	0	0
Trichloroethene	0	0	5	28	180	180	280	240	120	770	18

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AVERAGE CONCENTRATIONS OF SPECIFIC CHEMICALS AT RW-1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51
Elevation (msl)	45	-5	-55	-105	-125	-145	-165	-185	-205	-225	-245
Depth (bgs)	50	100	150	200	220	240	260	280	300	320	340
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	2	300	1	0	0	0	0
1,1 Dichloroethene	0	0	0	28	10	9	0	0	0	2	0
1,1 Dichloroethane	0	0	0	0	2	4	0	0	1	4	0
1,2 Dichloroethene	0	0	0	1	30	1100	5	0	49	0	7
Chloroform	0	0	0	0	0	0	0	0	1	1	0
1,2 Dichloroethane	0	0	0	0	0	0	0	0	0	0	0
1,1,1 Trichloroethane	0	0	0	110	15	0	0	0	0	2	0
Carbon Tetrachloride	0	0	0	0	0	0	0	0	0	0	0
1,1,2 Trichloroethane	0	0	0	0	0	0	0	0	0	0	0
Benzene	0	0	0	0	0	0	0	0	0	0	0
Tetrachloroethene	0	0	0	32	790	900	11	2	220	150	12
Toluene	2	2	2	0	0	0	1	2	0	0	2
Chlorobenzene	0	0	0	0	2	1	0	0	0	0	0
Ethyl Benzene	0	0	0	0	0	0	0	0	0	0	0
o Xylene	0	0	0	0	0	0	0	0	0	0	0
m + p Xylene	0	0	0	0	0	0	0	0	0	0	0
ter.ButylMethylEther	0	0	0	0	0	0	0	0	0	0	0
Trichloroethene	0	0	0	2	30	830	6	0	110	83	13

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AVERAGE CONCENTRATIONS OF SPECIFIC CHEMICALS AT RW-1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-51	VPB-51	VPB-51	VPB-51	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38
Elevation (msl)	-265	-285	-305	-325	45	45	-5	-55	-145	-155	-165
Depth (bgs)	360	380	400	420	50	50	100	150	240	250	260
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	0	0	0	0	0	0	0
1,1 Dichloroethene	0	0	0	0	2	1	0	0	0	3.4	3
1,1 Dichloroethane	0	0	0	0	0	0	0	0	0	1.8	1
1,2 Dichloroethene	0	0	3	0	0	0	0	0	1	3.1	10
Chloroform	0	0	0	0	2	2	0	0	0	2.2	6
1,2 Dichloroethane	0	0	0	0	0	0	0	0	0	2.5	8
1,1,1 Trichloroethane	0	0	0	0	17	16	0	1	1.6	2.8	2
Carbon Tetrachloride	0	0	0	0	0	0	0	0	0	0	4
1,1,2 Trichloroethane	0	0	0	0	0	0	0	0	0	0	0
Benzene	0	0	0	0	0	1	4	0	0	0	0
Tetrachloroethene	3	2	2	1	0	0	0	0	0	0	3
Toluene	3	4	0	0	0	4	15	1	0	2	0
Chlorobenzene	0	0	0	0	0	0	0	0	0	0	0
Ethyl Benzene	0	0	0	0	0	0	2	0	0	0	0
o Xylene	0	0	0	0	0	3	4	0	0	0	0
m + p Xylene	0	0	0	0	0	0	12	0	0	0	0
ter.ButylMethylEther	0	0	0	0	0	0	0	2	6.7	2.2	0
Trichloroethene	1	0	6	0	0	0	0	0	160	3400	2300

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AVERAGE CONCENTRATIONS OF SPECIFIC CHEMICALS AT RW-1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38
Elevation (msl)	-175	-185	-195	-195	-205	-215	-225	-235	-245	-255	-285
Depth (bgs)	270	280	290	290	300	310	320	330	340	350	380
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	0	0	0	0	0	0	0
1,1 Dichloroethene	0	1.9	3.6	3.3	0	0	1.5	4.6	6.8	2.8	2
1,1 Dichloroethane	0	0	1.1	1	0	0	0	3.3	2.6	1.5	0
1,2 Dichloroethene	5.9	5.6	6.5	6.2	3.3	2	3.4	1.4	1.6	1.4	3
Chloroform	6.2	5.6	4.5	4.3	1.9	1.9	2	0	0	0	0
1,2 Dichloroethane	15	7.8	8	7.5	3.8	2.7	3.2	0	0	0	0
1,1,1 Trichloroethane	0	1.3	2.5	2.5	0	0	1.3	4.4	5.8	2.3	2
Carbon Tetrachloride	0	0	0	0	0	0	0	0	0	0	0
1,1,2 Trichloroethane	3.5	3.1	1.5	1.5	1.3	0	0	0	0	0	0
Benzene	0	0	0	0	0	0	0	0	0	0	0
Tetrachloroethene	1.8	3	2.7	2.5	0	0	0	1.9	2.2	0	0
Toluene	0	2.3	0	0	0	2.8	0	0	0	0	0
Chlorobenzene	0	0	0	0	0	0	0	0	0	0	0
Ethyl Benzene	0	0	0	0	0	0	0	0	0	0	0
o Xylene	0	0	0	0	0	0	0	0	0	0	0
m + p Xylene	0	0	0	0	0	0	0	0	0	0	0
ter.ButylMethylEther	0	0	0	0	0	0	0	0	0	0	0
Trichloroethene	2400	2200	1100	1100	610	280	580	990	710	1300	500

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AVERAGE CONCENTRATIONS OF SPECIFIC CHEMICALS AT RW-1
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-38	VPB-38	VPB-38	Average
Elevation (msl)	-295	-305	-335	
Depth (bgs)	390	400	430	
Analyte (µg/L)				
Vinyl Chloride	0	0	0	6.5
1,1 Dichloroethene	1	0	0	2.0
1,1 Dichloroethane	0	0	0	0.8
1,2 Dichloroethene	4	4	0	41.8
Chloroform	0	1	0	1.0
1,2 Dichloroethane	0	0	0	1.2
1,1,1 Trichloroethane	0	0	0	4.1
Carbon Tetrachloride	0	0	0	0.1
1,1,2 Trichloroethane	1	1	0	0.3
Benzene	0	0	0	0.1
Tetrachloroethene	0	0	0	45.8
Toluene	0	0	0	1.0
Chlorobenzene	0	0	0	0.1
Ethyl Benzene	0	0	0	0.0
o Xylene	0	0	0	0.1
m + p Xylene	0	0	0	0.3
ter.ButylMethylEther	0	0	0	0.2
Trichloroethene	560	580	1	461.1
				566.5

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TABLE 2
ESTIMATED TVOC CONCENTRATIONS IN RW-2
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Elevation (msl)	Depth (bgs)	VPB-38 (330 ft West) Total VOCs (µg/L)		RW-2 (µg/L)		VPB-51 (410 ft East) Total VOCs (µg/L)
45	50	21				NA
	50	27				2
25	70	NA				NA
5	90	NA				NA
-5	100	37				2
-15	110	NA				NA
-35	130	NA				NA
-55	150	4				2
-75	170	NA				NA
-95	190	NA				NA
-105	200	NA				173
-115	210	NA				NA
-125	220	0				881
-135	230	NA				NA
-145	240	169				3144
-155	250	3420				NA
-165	260	2337				24
-175	270	2432				NA
-185	280	2231				4
-195	290	1130 1129				NA
-205	300	620				381
-215	310	289				NA
-225	320	591				242
-235	330	1006				NA
-245	340	729				34
-255	350	1308				NA
-265	360	NA				7
-275	370	NA				NA
-285	380	507				6
-295	390	566				NA
-305	400	586				11
-315	410	NA				NA
-325	420	NA				1
-335	430	1				NA
-345	440	NA				3
-355	450	875 862				NA
-365	460	566				49
-375	470	526				NA
-385	480	NA				0
-395	490	122				NA
-400	495	NA				NA
-405	500	NA				NA
-415	510	2				38
-425	520	NA				0
-435	530	0		274		NA
-445	540	12				29
-455	550	NA				NA
-465	560	0				17
-470	565	NA				NA
-475	570	4				NA
-485	580	NA				12
-495	590	NA				NA
-505	600	NA				3
-515	610	NA				NA
-520	615	NA				0
-525	620	1				NA
-535	630	NA				NA
-545	640	NA				0
-555	650	NA				NA
-565	660	NA				NA
-575	670	0				NA
-585	680	NA				NA
-595	690	NA				NA
-605	700	NA				2
-615	710	NA				NA
-625	720	NA				3
-635	730	NA				NA
-645	740	NA				NA
-655	750	NA				NA
-665	760	NA				NA
-675	770	NA				NA
-685	780	NA				0
-695	790	NA				NA
-705	800	NA				NA

Note: Ground surface elevation assumed to be constant as 95' above mean sea level.
NA = Not Analyzed
Bold = Concentration exceeds 500 µg/L.

AVERAGE CONCENTRATION OF SPECIFIC CHEMICALS IN RW-2
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38	VPB-38
Elevation (msl)	-245	-255	-285	-295	-305	-335	-355	-355	-365	-375	-395
Depth (bgs)	340	350	380	390	400	430	450	450	460	470	490
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	0	0	0	0	0	0	0
1,1 Dichloroethene	6.8	2.8	2	1	0	0	1	1	0	0	0
1,1 Dichloroethane	2.6	1.5	0	0	0	0	0	0	0	0	0
1,2 Dichloroethene	1.6	1.4	3	4	4	0	6	6	3	4	2
Chloroform	0	0	0	0	1	0	2	2	1	1	0
1,2 Dichloroethane	0	0	0	0	0	0	3	3	0	0	0
1,1,2 Trichloroethane	0	0	0	1	1	0	3	0	2	1	0
Tetrachloroethene	2.2	0	0	0	0	0	0	0	0	0	0
Trichloroethene	710	1300	500	560	580	1	860	850	560	520	120
	723.2	1305.7	505.0	566.0	586.0	1.0	875.0	862.0	566.0	526.0	122.0

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AVERAGE CONCENTRATION OF SPECIFIC CHEMICALS IN RW-2
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-38	VPB-38	VPB-38	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51	VPB-51
Elevation (msl)	-415	-445	-455	-245	-265	-285	-305	-325	-345	-365	-415
Depth (bgs)	510	530	540	340	360	380	400	420	440	460	510
Analyte (µg/L)											
Vinyl Chloride	0	0	0	0	0	0	0	0	0	0	0
1,1 Dichloroethene	0	0	0	0	0	0	0	0	0	0	0
1,1 Dichloroethane	0	0	0	0	0	0	0	0	0	3	0
1,2 Dichloroethene	0	0	0	7	0	0	3	0	1	17	11
Chloroform	0	0	0	0	0	0	0	0	0	2	0
1,2 Dichloroethane	0	0	0	0	0	0	0	0	0	0	0
1,1,2 Trichloroethane	0	0	0	0	0	0	0	0	0	2	0
Tetrachloroethene	0	0	0	12	3	2	2	1	0	0	0
Trichloroethene	2	0	12	13	1	0	6	0	2	25	27
	2.0	0.0	12.0	32.0	4.0	2.0	11.0	1.0	3.0	49.0	38.0

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AVERAGE CONCENTRATION OF SPECIFIC CHEMICALS IN RW-2
OFFSITE GM-38 AREA REMEDY
NWIRP BETHPAGE, NY

Boring ID	VPB-51	VPB-51	Average
Elevation (msl)	-425	-445	
Depth (bgs)	520	540	
Analyte (µg/L)			
Vinyl Chloride	0	3	0.1
1,1 Dichloroethene	0	0	0.6
1,1 Dichloroethane	0	0	0.3
1,2 Dichloroethene	0	11	3.5
Chloroform	0	0	0.4
1,2 Dichloroethane	0	0	0.3
1,1,2 Trichloroethane	0	0	0.4
Tetrachloroethene	0	10	1.3
Trichloroethene	0	5	277.3
	0.0	29.0	284.2

Attachment C-3
Re-Injection Well Calculations

SUSTAINABLE INJECTION RATE CALCULATIONS
NWIRP BETHPAGE, NEW YORK

Calculations were performed to estimate the per-well injection rate that could be sustained for disposal of treated water into the shallow aquifer at the site. The calculations were based on the assumption that the injection rate could be reasonably approximated using equations developed for estimating drawdown rates in pumping wells. A reasonable safety factor was added to account for the general tendency of injection wells to become less efficient over time, primarily due to clogging of the aquifer matrix by suspended solids, chemical precipitation, biological activity, and/or air entrainment. Major inputs/assumptions into the injection rate calculations include:

- Injection is to be performed in the shallow (top 100 feet) portion of the aquifer. Based on the groundwater flow model setup, the top 50 feet of the aquifer has an average hydraulic conductivity (K) of 300 ft/day, while the next 50 feet has an average K of 120 ft/day, for an overall average K for the top 100 feet of 210 ft/day. Phase 2 remedial investigation pumping test results, on the other hand, suggest an average K of about 100 ft/day for the Upper Glacial and Magothy aquifers.

- The aquifer has an average effective porosity and specific yield of 0.30 (from groundwater flow model setup data).

- A maximum increase in hydraulic head of approximately 25 feet (½ the unsaturated zone thickness of 50 feet) is allowed.

- Each of the injection wells have a radius of one foot.

- Equilibrium (steady-state) hydraulic head conditions are established within 30 days of beginning injection activities.

- The long term injection well efficiency is assumed to be 50% of the theoretical (calculated) maximum.

- A baseline target cumulative injection rate of approximately 1,100 gpm is assumed. In addition, cumulative pumping rates of 1650 gpm and 2200 gpm were also considered, to cover a range of possible pumping rates up to 2x the baseline rate.

Table 1 provides the results of the injection calculations for various levels of water level rise. For an aquifer with an average K of 210 ft/day, an injection rate of 550 gpm will result in a rise in water level at the injection well of approximately 12.4 feet, assuming 50% efficiency. At 1,100 gpm, the water level rise at the injection well is approximately 25 feet, indicating that one injection well could potentially handle up to 1,100 gpm on a long term basis. Based on this, injection rates of 1650 or 2200 gpm would require a minimum of 2 injection wells (disregarding the incremental additive effects of other injection wells for multiple injection well scenarios).

For an aquifer with an average K of 100 ft/day, an injection rate of 550 gpm will result in a rise in water level at the injection well of approximately 25 feet, assuming 50% efficiency (Table 1), indicating that at least two injection wells would be required to handle 1,100 gpm on a long term basis. Based on the calculations, injection rates of 1650 or 2200 gpm would require at least 3 or 4 injection wells, respectively (again disregarding the incremental additive effects of other injection wells for multiple injection well scenarios).

Table 2 shows the water level rises calculated for various distances from injection wells operating at injection rates of 550, 825, and 1,100 gpm, assuming an aquifer K of 210 ft/day, to quantify the incremental additive effects for various scenarios regarding the number and placement of multiple injection wells. Table 3 shows water level rises at various distances from injection wells operating at injection rates of 275, 367, and 550 gpm, assuming an aquifer K of 100 ft/day. As can be seen by the data in the tables and on the accompanying graphs (Graphs 1 and 2), the hydraulic head increases drop off quickly with increasing distance from the injection well.

Based on the injection rate calculations and an assumed representative K of 210 ft/day, two wells should adequately handle a cumulative 1,100 gpm injection rate (550 gpm per well) with a substantial safety factor added in. If the wells are positioned approximately 100 feet apart, the total water level rise at each well would be approximately 15 feet (12.4 feet from direct injection, assuming 50% well efficiency, and a 3 foot water level rise due to the operation of the nearby second injection well). Alternatively, one injection well could be operated at 1,100 gpm if a water level rise of approximately 25 feet is determined to be acceptable. For injection rate of 1650 gpm, a minimum of 2 injection wells is necessary, and for an injection rate of 2200 gpm, at least 3 injection wells are required.

Based on the injection rate calculations and an assumed representative K of 100 ft/day, three wells should adequately handle a cumulative 1,100 gpm injection rate (367 gpm per well) with a small safety factor added in. If the wells are positioned approximately 100 feet apart, the total water level rise at each well would be approximately 22.5 feet (16.5 feet from direct injection, assuming 50% well efficiency, and an additional 6 foot water level rise due to the operation of the other two injection wells). Alternatively, two injection wells could be operated at 550 gpm if a water level rise of approximately 30 feet is determined to be acceptable. For injection rate of 1650 gpm, a minimum of 4-5 injection wells is necessary, and for an injection rate of 2200 gpm, at least 6 injection wells are required.

Table 1
Groundwater Injection Rate Calculations
NWIRP Bethpage, New York

Water level rise, s (ft)	T ft^2/day	S	Well radius, r (ft)	Time, t (days)	$(4\pi Ts/2.3)$	$\log(2.25Tt/r^2S)$	Injection rate ft^3/day	Injection rate gpm	Injection rate, gpm at 50% efficiency
Avg K = 210 ft/day									
6.2	21000	0.3	1	30	711365.25	6.67	106581.12	553.64	276.82
12.4	21000	0.3	1	30	1422730.50	6.67	213162.25	1107.28	553.64
18.5	21000	0.3	1	30	2122622.11	6.67	318024.32	1651.99	825.99
24.7	21000	0.3	1	30	2833987.36	6.67	424605.45	2205.63	1102.81
Avg K = 100 ft/day									
12.4	10000	0.3	1	30	677490.71	6.35	106654.79	554.02	277.01
16.5	10000	0.3	1	30	901499.74	6.35	141919.68	737.21	368.60
18.5	10000	0.3	1	30	1010772.43	6.35	159122.07	826.57	413.28
24.7	10000	0.3	1	30	1349517.79	6.35	212449.47	1103.58	551.79

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$Q = (4\pi Ts/2.3)/\log(2.25Tt/r^2S)$

Q = Injection rate
T = transmissivity (assume injection in the top 100 feet of the aquifer)
s = selected water level rise in the injection well (the vadose zone is approximately 50 ft thick)
S = storativity
r = well radius
t = time required to reach steady-state conditions

Calculations assume that theoretical injection rates can be calculated as equivalent to pumping rate drawdowns

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Table 2
Calculated Water Level Rises
Due to Injection
NWIRP Bethpage, New York

Injection Rate (Q), gpm	Radial Distance (r), ft	Q, ft^3/day	T, ft^2/day	t, days	S	2.3Q/4πT	Log (2.25Tt/ r^2S)	Water level rise at distance r, ft
550	1	105882	21000	30	0.3	0.9227	6.67	6.16
550	10	105882	21000	30	0.3	0.9227	4.67	4.31
550	25	105882	21000	30	0.3	0.9227	3.88	3.58
550	50	105882	21000	30	0.3	0.9227	3.28	3.02
550	100	105882	21000	30	0.3	0.9227	2.67	2.47
550	150	105882	21000	30	0.3	0.9227	2.32	2.14
550	225	105882	21000	30	0.3	0.9227	1.97	1.82
550	300	105882	21000	30	0.3	0.9227	1.72	1.59
550	400	105882	21000	30	0.3	0.9227	1.47	1.36
550	600	105882	21000	30	0.3	0.9227	1.12	1.03
825	1	158824	21000	30	0.3	1.3840	6.67	9.24
825	10	158824	21000	30	0.3	1.3840	4.67	6.47
825	25	158824	21000	30	0.3	1.3840	3.88	5.37
825	50	158824	21000	30	0.3	1.3840	3.28	4.53
825	100	158824	21000	30	0.3	1.3840	2.67	3.70
825	150	158824	21000	30	0.3	1.3840	2.32	3.21
825	225	158824	21000	30	0.3	1.3840	1.97	2.73
825	300	158824	21000	30	0.3	1.3840	1.72	2.38
825	400	158824	21000	30	0.3	1.3840	1.47	2.03
825	600	158824	21000	30	0.3	1.3840	1.12	1.55
1100	1	211765	21000	30	0.3	1.8454	6.67	12.32
1100	10	211765	21000	30	0.3	1.8454	4.67	8.63
1100	25	211765	21000	30	0.3	1.8454	3.88	7.16
1100	50	211765	21000	30	0.3	1.8454	3.28	6.05
1100	100	211765	21000	30	0.3	1.8454	2.67	4.94
1100	150	211765	21000	30	0.3	1.8454	2.32	4.29
1100	225	211765	21000	30	0.3	1.8454	1.97	3.64
1100	300	211765	21000	30	0.3	1.8454	1.72	3.17
1100	400	211765	21000	30	0.3	1.8454	1.47	2.71
1100	600	211765	21000	30	0.3	1.8454	1.12	2.06

Water level rise = $(2.3Q/4\pi T) \times \text{Log}(2.25Tt/r^2S)$

T = transmissivity S = storativity Q = Injection rate
r = radial distance from the injection well to the observation point t = time required to reach equilibrium conditions

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5.18

Table 3
Calculated Water Level Rises
Due to Injection, K = 100 ft/day
NWIRP Bethpage, New York

Injection Rate (Q), gpm	Radial Distance (r), ft	Q, ft^3/day	T, ft^2/day	t, days	S	$2.3Q/4\pi T$	Log ($2.25Tt/r^2S$)	Water level rise at distance r, ft
275	1	52941	10000	30	0.3	0.9688	6.35	6.15
275	10	52941	10000	30	0.3	0.9688	4.35	4.22
275	25	52941	10000	30	0.3	0.9688	3.56	3.45
275	50	52941	10000	30	0.3	0.9688	2.95	2.86
275	100	52941	10000	30	0.3	0.9688	2.35	2.28
275	150	52941	10000	30	0.3	0.9688	2.00	1.94
275	225	52941	10000	30	0.3	0.9688	1.65	1.60
275	300	52941	10000	30	0.3	0.9688	1.40	1.35
275	400	52941	10000	30	0.3	0.9688	1.15	1.11
275	600	52941	10000	30	0.3	0.9688	0.80	0.77
367	1	70652	10000	30	0.3	1.2929	6.35	8.21
367	10	70652	10000	30	0.3	1.2929	4.35	5.63
367	25	70652	10000	30	0.3	1.2929	3.56	4.60
367	50	70652	10000	30	0.3	1.2929	2.95	3.82
367	100	70652	10000	30	0.3	1.2929	2.35	3.04
367	150	70652	10000	30	0.3	1.2929	2.00	2.59
367	225	70652	10000	30	0.3	1.2929	1.65	2.13
367	300	70652	10000	30	0.3	1.2929	1.40	1.81
367	400	70652	10000	30	0.3	1.2929	1.15	1.48
367	600	70652	10000	30	0.3	1.2929	0.80	1.03
550	1	105882	10000	30	0.3	1.9376	6.35	12.31
550	10	105882	10000	30	0.3	1.9376	4.35	8.43
550	25	105882	10000	30	0.3	1.9376	3.56	6.89
550	50	105882	10000	30	0.3	1.9376	2.95	5.72
550	100	105882	10000	30	0.3	1.9376	2.35	4.56
550	150	105882	10000	30	0.3	1.9376	2.00	3.88
550	225	105882	10000	30	0.3	1.9376	1.65	3.19
550	300	105882	10000	30	0.3	1.9376	1.40	2.71
550	400	105882	10000	30	0.3	1.9376	1.15	2.22
550	600	105882	10000	30	0.3	1.9376	0.80	1.54

Water level rise = $(2.3Q/4\pi T) \times \text{Log}\,(2.25Tt/r^2S)$

T = transmissivity S = storativity Q = Injection rate
r = radial distance from the injection well to the observation point t = time required to reach equilibrium conditions

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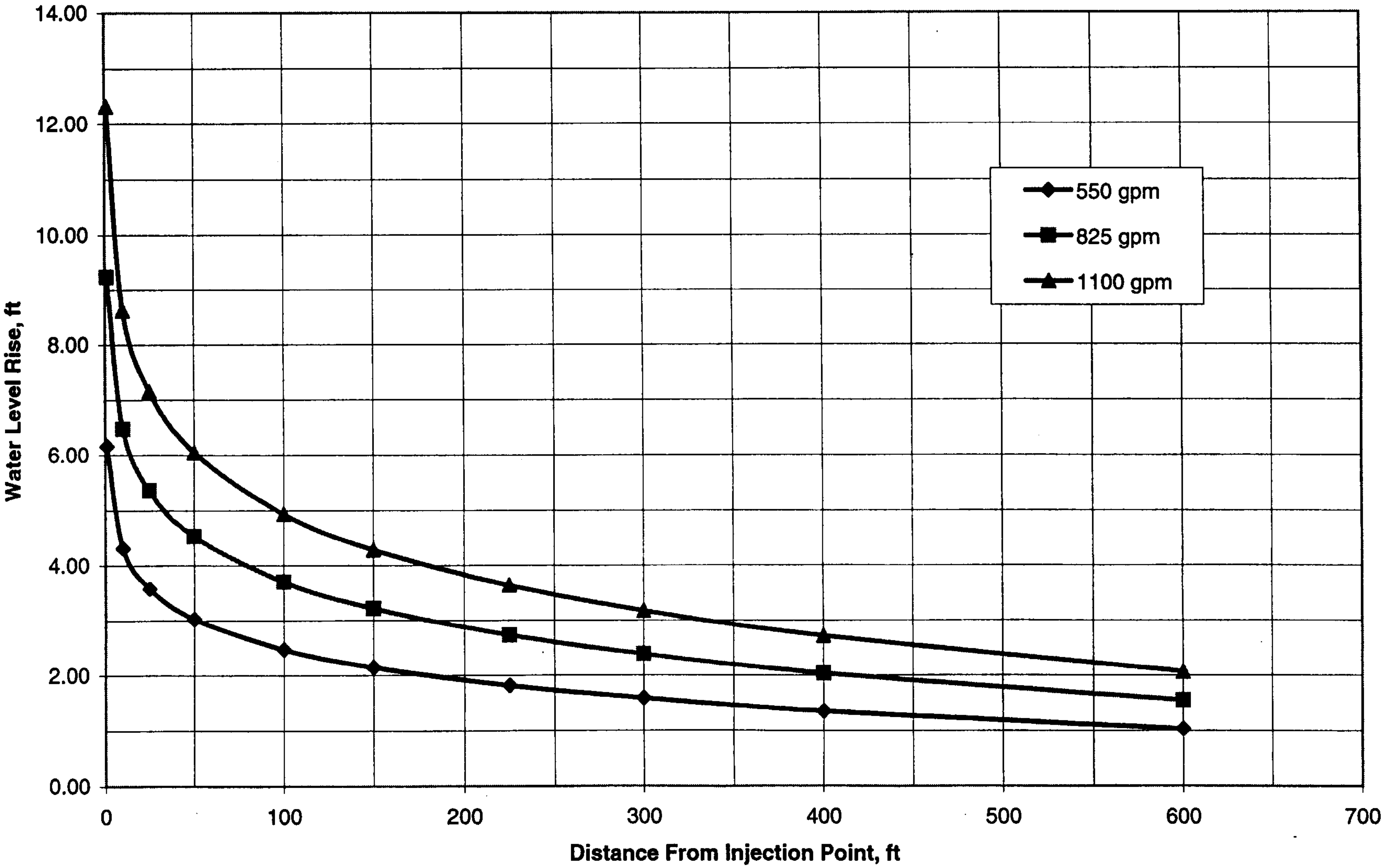
Graph 1
Water Level Rise Due to Injection, K = 210 ft/day



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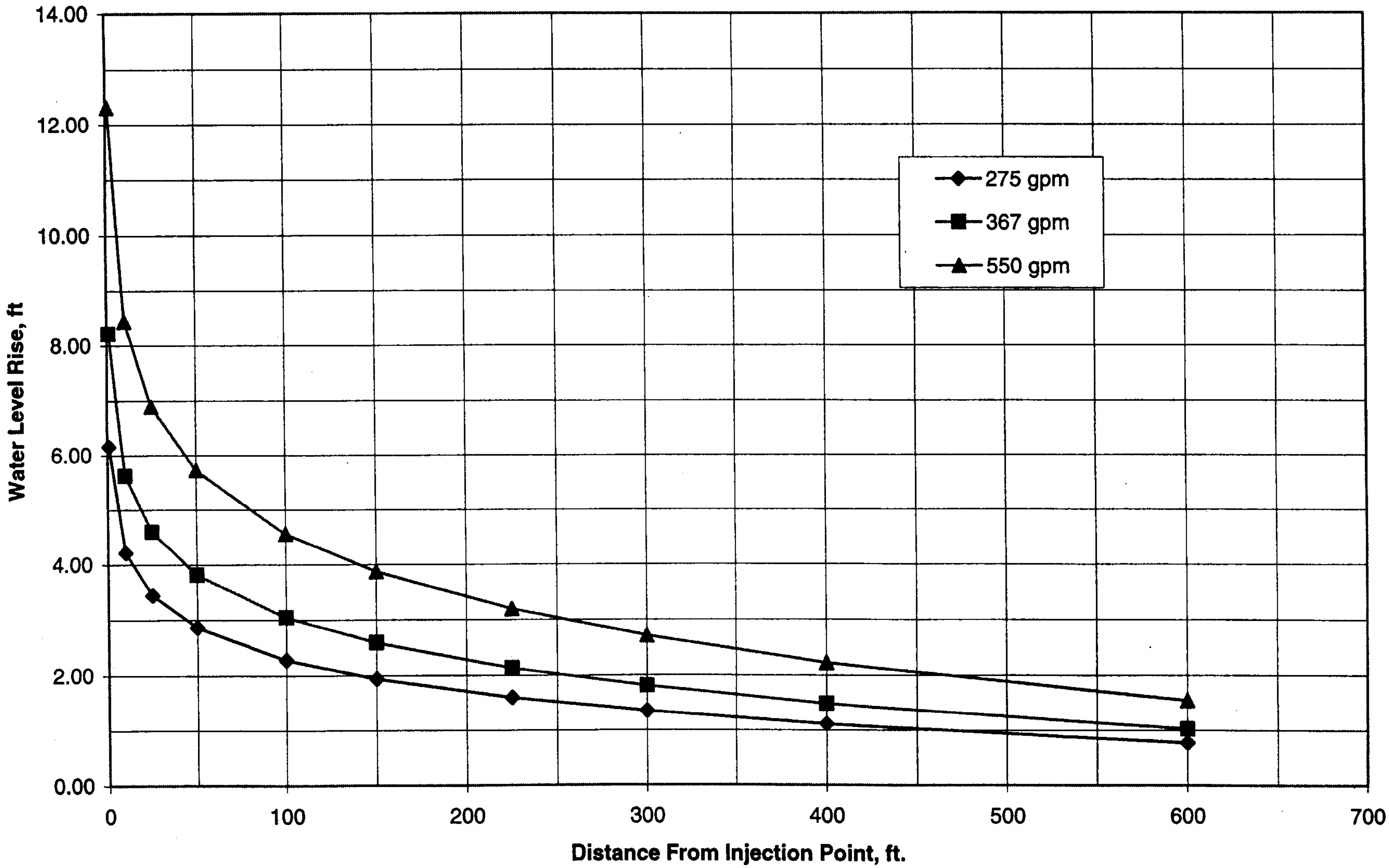
Graph 2
Water Level Rise Due to Injection, K = 100 ft/day



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Attachment C-4
Air Stripper Column Calculations

```
AIRSTRIP.EXE

AIRSTRIP Release 1.2                                        Copyright [illegible]

                            Summary of Selected Design

Contaminant             : Vinylchloride
Concentration In        :    4.8 ug/L
Concentration Out       :    0.0 ug/L
Percentage Removed      :  100.0 %
Packing                 : P-Jaeger Tripacks  3.5 inch
Water Temperature       :  55.0 deg F.
Atmospheric Pressure    :   1.0 atm
Packing Depth           :  25.0 feet
Liquid Loading Rate     :  14.0 gpm/ft^2
Air/Water Ratio         :   50
Stripping Factor        : 119.5
Air Pressure Gradient   :  <.06  " H2O/ft


F10 Toggle to Metric units          F1 Help             F7 Quit program
F6 Save design    "P" print report  F3 Main menu        Esc to go back
```

VC REMOVAL AVG. CONDITIONS

AIRSTRIP.EXE

```
Contaminant            : cis-1,2-Dichloroethylene
Concentration In       :   31.5 ug/L
Concentration Out      :    0.0 ug/L
Percentage Removed     :   99.9 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       :  11.2
Air Pressure Gradient  :  <.06   " H2O/ft

F10 Toggle to Metric units            F1 Help           F7 Quit program
F6 Save design   "P" print report     F3 Main menu      Esc to go back
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CIS-1,2-DCE REMOVAL, AUG. CONDITIONS

AIRSTRIP.EXE

```
Contaminant            : 1,2-Dichloroethane
Concentration In       :    1.0 ug/L
Concentration Out      :    0.1 ug/L
Percentage Removed     :   91.0 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       :   2.1
Air Pressure Gradient  :  <.06  " H2O/ft

F10 Toggle to Metric units          F1 Help          F7 Quit program
F6 Save design   "P" print report   F3 Main menu     Esc to go back
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1,2 DCA REMOVAL, AVG. CONDITIONS

AIRSTRIP.EXE

```
Contaminant             : Tetrachloroethylene
Concentration In        :   33.8 ug/L
Concentration Out       :    0.0 ug/L
Percentage Removed      :   99.9 %
Packing                 : P-Jaeger Tripacks  3.5 inch
Water Temperature       :  55.0 deg F.
Atmospheric Pressure    :   1.0 atm
Packing Depth           :  25.0 feet
Liquid Loading Rate     :  14.0 gpm/ft^2
Air/Water Ratio         :   50
Stripping Factor        :  21.2
Air Pressure Gradient   :  <.06  " H2O/ft

F10 Toggle to Metric units             F1 Help          F7 Quit program
F6 Save design   "P" print report      F3 Main menu     Esc to go back
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PCE REMOVAL, AVG. CONDITIONS

AIRSTRIP.EXE

```
Contaminant            : Trichloroethylene
Concentration In       :  411.5 ug/L
Concentration Out      :    0.5 ug/L
Percentage Removed     :   99.9 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       :  13.3
Air Pressure Gradient  :  <.06   " H2O/ft

F10 Toggle to Metric units           F1 Help          F7 Quit program
F6 Save design   "P" print report    F3 Main menu     Esc to go back
```

TCE REMOVAL, AVG. CONDITIONS

AIRSTRIP.EXE

```
Contaminant            : Vinylchloride
Concentration In       :  300.0 ug/L
Concentration Out      :    0.0 ug/L
Percentage Removed     :  100.0 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       : 119.5
Air Pressure Gradient  :  <.06  " H2O/ft

F10 Toggle to Metric units         F1 Help          F7 Quit program
F6 Save design   "P" print report  F3 Main menu     Esc to go back
```

VC REMOVAL, MAX. CONDITIONS

AIRSTRIP.EXE

Contaminant	: cis-1,2-Dichloroethylene
Concentration In	: 1.1 mg/L
Concentration Out	: 1.3 ug/L
Percentage Removed	: 99.9 %
Packing	: P-Jaeger Tripacks 3.5 inch
Water Temperature	: 55.0 deg F.
Atmospheric Pressure	: 1.0 atm
Packing Depth	: 25.0 feet
Liquid Loading Rate	: 14.0 gpm/ft^2
Air/Water Ratio	: 50
Stripping Factor	: 11.2
Air Pressure Gradient	: <.06 " H2O/ft

F10 Toggle to Metric units　　F1 Help　　F7 Quit program
F6 Save design　"P" print report　　F3 Main menu　　Esc to go back

CIS-1,2-DCE REMOVAL, MAX. CONDITIONS

AIRSTRIP.EXE

```
Contaminant            : 1,2-Dichloroethane
Concentration In       :    3.0 ug/L
Concentration Out      :    0.3 ug/L
Percentage Removed     :   91.0 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       :   2.1
Air Pressure Gradient  :  <.06  " H2O/ft

F10 Toggle to Metric units          F1 Help           F7 Quit program
F6 Save design   "P" print report   F3 Main menu      Esc to go back
```

1,2 DCA REMOVAL, MAX. CONDITIONS

AIRSTRIP.EXE

AIRSTRIP Rel. 1.2 Copyright 19..

Summary of Selected Design

```
Contaminant            : Tetrachloroethylene
Concentration In       :  900.0 ug/L
Concentration Out      :    0.9 ug/L
Percentage Removed     :   99.9 %
Packing                : P-Jaeger Tripacks  3.5 inch
Water Temperature      :  55.0 deg F.
Atmospheric Pressure   :   1.0 atm
Packing Depth          :  25.0 feet
Liquid Loading Rate    :  14.0 gpm/ft^2
Air/Water Ratio        :   50
Stripping Factor       :  21.2
Air Pressure Gradient  :  <.06  " H2O/ft

F10 Toggle to Metric units              F1 Help            F7 Quit program
F6 Save design    "P" print report      F3 Main menu       Esc to go back
```

PCE REMOVAL, MAX. CONDITIONS

AIRSTRIP.EXE

Contaminant	:	Trichloroethylene
Concentration In	:	3.4 mg/L
Concentration Out	:	4.5 ug/L
Percentage Removed	:	99.9 %
Packing	:	P-Jaeger Tripacks 3.5 inch
Water Temperature	:	55.0 deg F.
Atmospheric Pressure	:	1.0 atm
Packing Depth	:	25.0 feet
Liquid Loading Rate	:	14.0 gpm/ft^2
Air/Water Ratio	:	50
Stripping Factor	:	13.3
Air Pressure Gradient	:	<.06 " H2O/ft

F10 Toggle to Metric units F1 Help F7 Quit program
F6 Save design "P" print report F3 Main menu Esc to go back

TCE REMOVAL, MAX. CONDITIONS

APPENDIX D

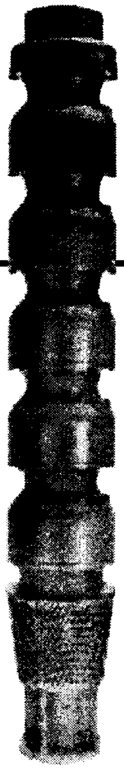
TYPICAL EQUIPMENT CATALOG CUTS

GOULDS PUMPS

P-1

5" – 10" Texas Submersible Turbine Pumps

For 6" and larger wells



SPECIFICATIONS

Model	Operating Range GPM	Best Efficiency Range	Horsepower Range	Discharge Connections	Minimum Well Size
5WALC	15 – 80	50	5 – 20	3", 4"	6"
5WAHC	20 – 100	70	5 – 25	3", 4"	6"
5CLC	50 – 180	110	5 – 30	3", 4"	6"
5CHC	70 – 220	150	5 – 50	3", 4"	6"
5TLC	75 – 220	170	5 – 40	3", 4"	6"
5THC	150 – 300	240	5 – 60	3", 4"	6"
6CLC	100 – 200	160	5 – 40	3", 4"	8"
6CHC	150 – 300	225	5 – 50	3", 4"	8"
6DLC	200 – 450	350	5 – 30	3", 4"	8"
6DHC	300 – 550	425	5 – 30	3", 4"	8"
7WALC	150 – 300	250	7½ – 60	4", 5", 6"	8"
7WAHC	200 – 350	275	10 – 75	4", 5", 6"	8"
7CLC	250 – 460	350	10 – 100	4", 5", 6"	8"
7CHC	300 – 600	450	15 – 100	4", 5", 6"	8"
7TLC	300 – 650	500	10 – 100	4", 5", 6"	8"
7THC	400 – 800	700	15 – 100	4", 5", 6"	8"
9WALC	250 – 550	400	15 – 100	5", 6", 8"	10"
9WAHC	300 – 600	425	20 – 150	5", 6", 8"	10"
9RCLC	400 – 1200	900	40 – 150	5", 6", 8"	10"
9RCHC	500 – 1400	1000	60 – 150	5", 6", 8"	10"
9TLC	750 – 1700	1250	40 – 150	5", 6", 8"	10"
9THC	800 – 2000	1600	60 – 150	5", 6", 8"	10"
10JLC	700 – 1250	1000	30 – 150	6", 8"	12"

FEATURES

■ **Discharge Bowl:** Several discharge sizes available for NPT.

■ **Discharge Bearing:** Extra long sealed top bronze bearing insures positive shaft alignment and stabilization for extended life.

■ **Intermediate Bowl:** Close grained class 30 cast iron. Nonmetallic coatings on 7" and larger pumps for maximum efficiency and abrasion resistance.

■ **Impellers:** Unleaded silicon brass impellers are made of ASTM B584 C87500. Designed for maximum efficiency with wide range hydraulic coverage.

■ **Upthrust Collar:** Designed for extra margin of safety against possible momentary upthrust occurring at start-up.

■ **Intermediate Bowl Bearings:** Reliable long life rubber bearings (optional bronze available).

■ **Taperlocks:** Accurately machined to insure positive locking of impeller to pump shaft.

■ **Suction Inlet:** Contoured for smooth flow entrance. Protected by an oversized stainless steel strainer to prevent entrance of damaging solids.

■ **Suction Adapter:** Ductile iron for increased strength and positive motor alignment. Open area permits easy access to pump/motor coupling.

■ **Pump and Motor Coupling:** Large stainless steel coupling accurately matched for perfect alignment, balance and power transmission.

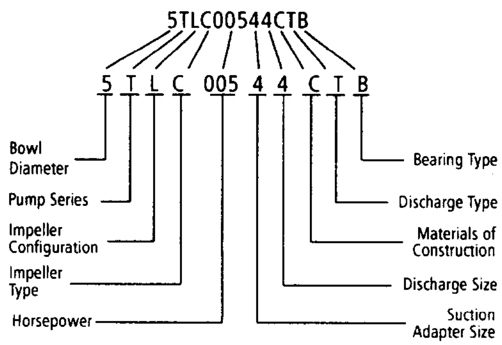
■ **Pump Shaft:** 100,000 PSI high tensile stainless steel provides strength and excellent corrosion resistance. Ground and polished for smooth bearing surface.

■ **Powered for Continuous Operation:** All ratings are within the working limits of the motor manufacturer. Pump can be operated continuously without fear of damage to the motor.

■ **Franklin Electric Motor:**
- Corrosion-resistant construction.
- Stainless steel splined shaft.
- Hermetically sealed windings.
- Anti-track self-healing resin system.
- Water lubrication.
- Filter check valve.
- Kingsbury-type thrust bearing.
- Pressure equalizing diaphragm.
- Sand fighter slinger.
- Removable water-bloc lead connector.
- UL 778 recognized.

Goulds Pumps is ISO 9001 Registered.

ORDER NUMBER CODE



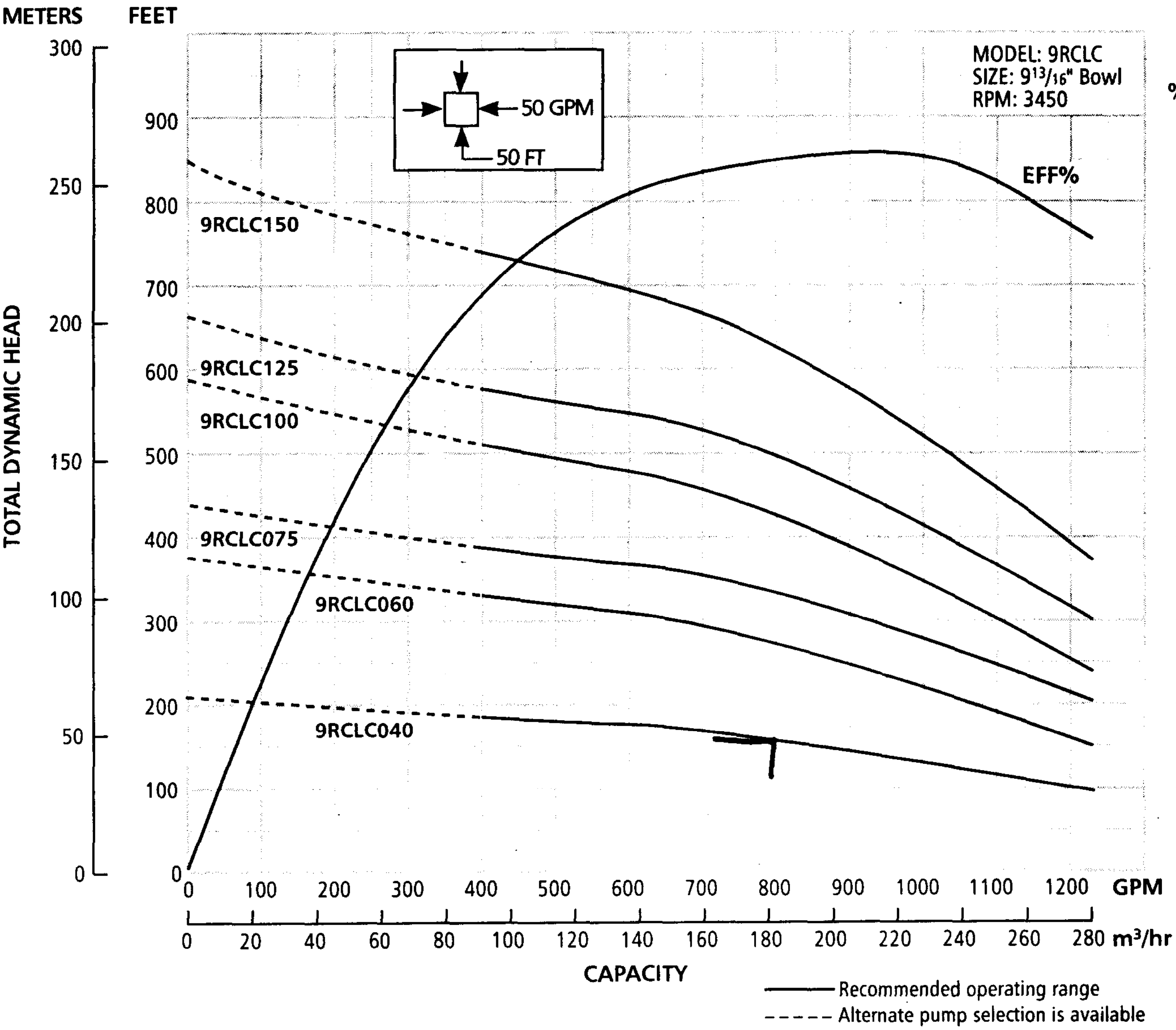
Goulds Pumps

ITT Industries

 D-1

Model 9RCLC 900 GPM

GOULDS PUMPS



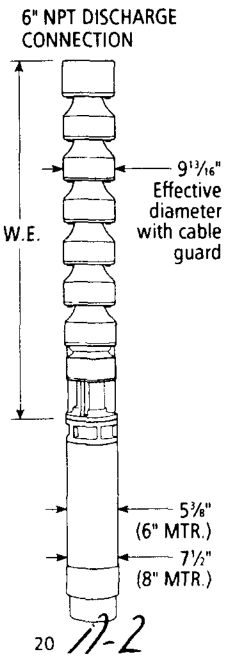
DIMENSIONS AND WEIGHTS

HP	Stages	W.E. Order Number	W.E. Length	W.E. Wt. (lbs.)
40	1	9RCLC04066ATS	28.0	194
60	2	9RCLC06066ATS	36.6	258
75	2	9RCLC07586ATS	34.8	270
100	3	9RCLC10086ATS	43.2	334
125	3	9RCLC12586ATS	43.2	334
150	4	9RCLC15086ATS	51.8	398

(All dimensions in inches and weights in lbs. Do not use for construction purposes.)

PLEASE NOTE:

- Order motors separately.
- *For intermediate horsepower pumps consult factory.*
- Solid line is recommended operating range. The dotted line (– – – –) signifies an alternate pump selection is available.
- Please specify all options changes in W.E. order number.



MATERIALS OF CONSTRUCTION

Part Name	Material
Shaft	ASTM A582 TYPE 416
Coupling	ASTM A582 S41600 CD
Suction Adapter	Ductile Iron ASTM A536
Discharge Bowl	ASTM A48 CL 30B
Rubber Bearings	RUBBER
Optional Bronze Bearings	ASTM B584
Discharge Bowl Bearing	ASTM B584
Taperlocks	ASTM A108 GR 1018
Bowl	ASTM A48 CL 30B
Upthrust Collar	Polyethylene
Impeller	ASTM B584
Fasteners	SAEJ429 GR 8
Cable Guard	ASTM A240 S 30400
Suction Strainer	ASTM A240 S 30400

GOULDS PUMPS

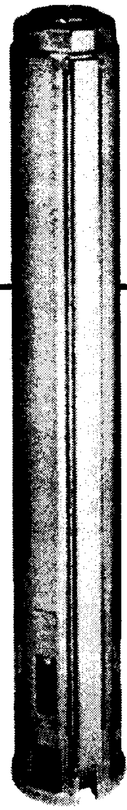
60 Hz High Capacity Stainless Steel 6" Submersible Pumps

P-2

MODEL L

70L, 90L, 150L, 200L, 300L

For 6" and larger wells



SPECIFICATIONS

Model	Horsepower	Discharge Connection	Recommended GPM Operating Range	GPM at Best Efficiency	Minimum Well Size	Rotation①
70L	3 – 25	3" NPT	25 – 100	70	6"	CCW
90L	5 – 30	3" NPT	40 – 130	90	6"	CCW
150L	5 – 40	3" NPT	50 – 240	150	6"	CCW
200L	7.5 – 40	3" NPT	70 – 310	200	6"	CCW
→ 300L	5 – 40	3" NPT	100 – 450	300	6"	CCW

① Rotation when viewed from pump discharge end.

"L" SERIES MATERIALS OF CONSTRUCTION

Part Name	Material
Shaft and Coupling	420, 421 Series SS
Motor Adapter and Discharge Head	304 Series SS
Bearing	NBR
Shaft Sleeves	304 Series SS
Bowl	304 Series SS
Diffuser and Impeller	304 Series SS
Casing	304 Series SS
Fasteners	304 Series SS
Cable Guard	304 Series SS
Suction Strainer	304 Series SS
Casing Nut	316L Powder Metal
Wear Rings	NBR

ORDER NUMBER CODE

70 L 03

Pump Size/ Gallons per minute at Best Efficiency Point: 90, 150, 200, 300

Pump Series

Horsepower Code = HP
03 = 3
05 = 5
07 = 7.5
10 = 10
15 = 15
20 = 20
25 = 25
30 = 30
40 = 40

FEATURES

■ **Powered for Continuous Operation:** All ratings are within the working limits of the motor manufacturer. Pump can be operated continuously with no fear of damage to the motor.

■ **Completely Field Serviceable:** Easy to install and service. All parts easily dismantled if field service is ever necessary.

■ **Diverse Application:** Designed for commercial, municipal and agricultural water needs.

■ **Polished Stainless Steel Casing:** Durable in the most corrosive waters.

■ **Bearings:** Replaceable fluted NBR bearings allow excellent abrasives handling and wear resistance.

■ **Built-in Rugged Check Valve:** Positive sealing, stainless steel check valve assembly incorporated into discharge head.

■ **Bowls:** Stainless with pressed in NBR wear rings. 70L and 90L are a flat bowl design. 150L, 200L and 300L are a turbine bowl design.

■ **Impellers:** Rugged stainless steel construction resists mineral and algae deposits.

■ **Stainless Steel Shaft Sleeve:** Corrosion resistant.

■ **Four-Fluted Shaft Design:** Four sided stainless steel shaft eliminates impeller keys and provides positive drive.

■ **Coupling:** Heavy duty stainless steel, splined coupling for maximum load-carrying capability.

■ **Suction Strainer:** Stainless steel strainer restricts gravel and other debris from entering the pump.

■ **Cable Guard:** Stainless steel cable guard surrounds and protects motor leads.

■ **Fasteners:** All fasteners are stainless steel.

■ **Franklin Electric Motor:** Stainless steel casing and epoxy coated end bells resist corrosion. Water filled design provides a constant supply of lubrication. Hermetically sealed stator assures moisture free windings. Durable Kingsbury type thrust bearing absorbs all thrust. Replaceable motor lead assembly.

SYSTEM COMPONENTS

■ **Pump/Water End:**
- 6" Pump with 3" NPT discharge.
- 4" Motor Adapter on 3 and 5 HP models.
- 6" Motor Adapter on 7.5 HP and larger models.

■ **Motor:**
- 4" motor required for 3 HP and 5 HP pumps.
- 6" motor required for 7.5 HP and larger pumps.
- Effective February, 1994, 4" and 6" Franklin Electric Motors have motor leads installed at the factory.

■ **Control Box:** Required for all single phase motors.

■ **Magnetic Starter:** A magnetic starter and heaters* are required for all three phase units.

*Requires 3 ambient compensated (K type) quicktrip heaters.

ALL COMPONENTS MUST BE ORDERED SEPARATELY AND ARE PACKAGED SEPARATELY.

Goulds Pumps is ISO 9001 Registered.

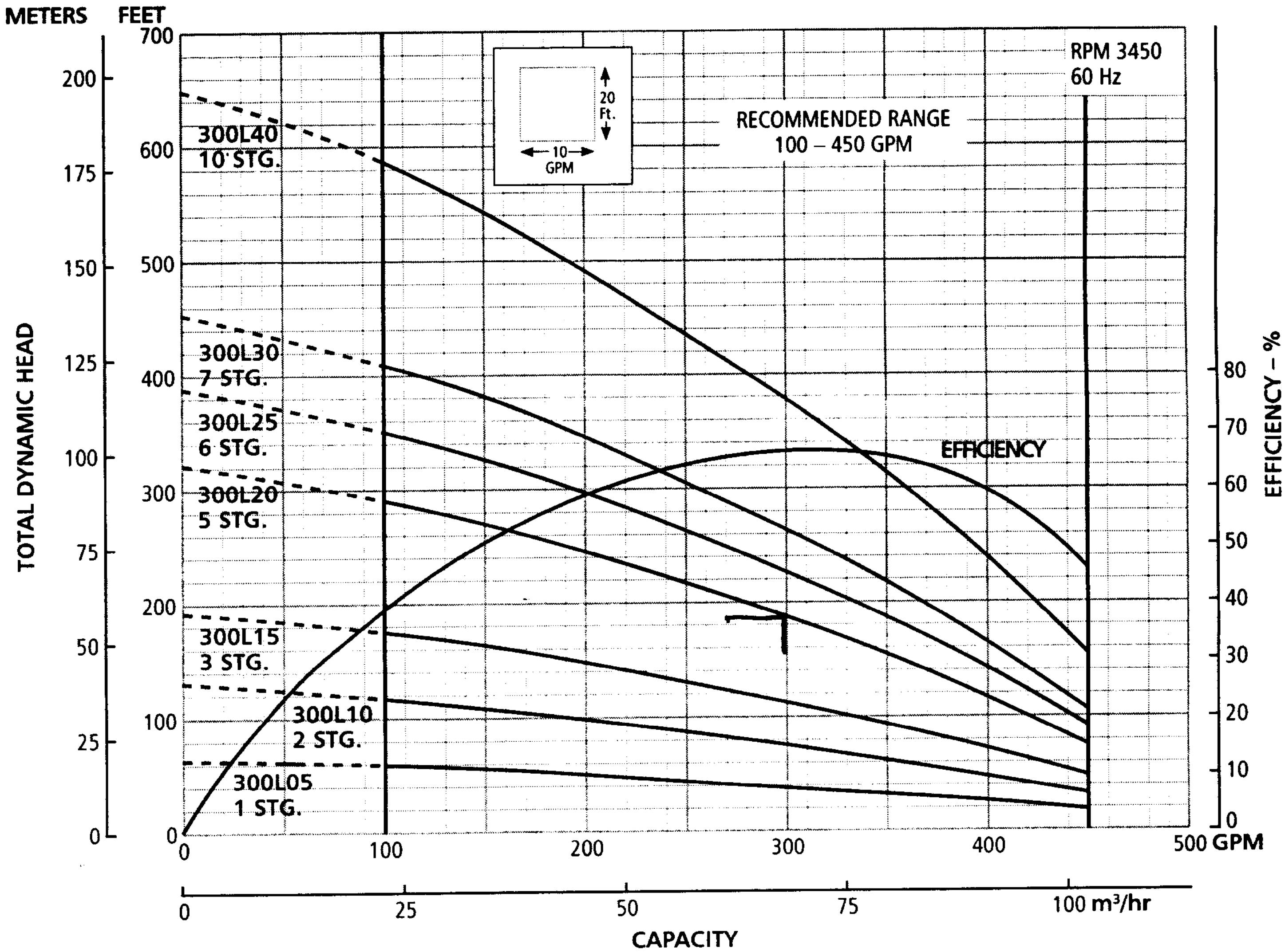
Goulds Pumps

ITT Industries

D-3

Model 300L

GOULDS PUMPS

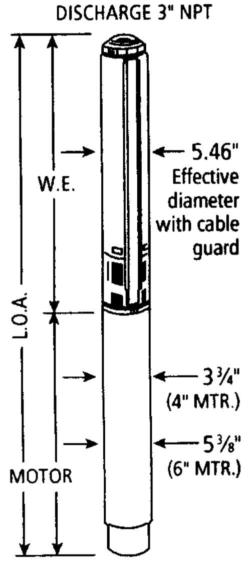


DIMENSIONS AND WEIGHTS

HP	Stages	W.E. Order No.	Motor Order No.	PH	Motor Volts	Motor Length	W.E. Length	L.O.A.	Wt. (lbs.)
5	1	300L05	S10940	1	230	28.2	23.5	51.7	74
			S10978 S10970 S10975 *S10979	3	200 230 460 575	22.2	23.5	45.7	74
10	2	300L10	S12970	1	230	30.6	28.0	58.6	165
			S12978 S12971 S12972 *S12979	3	200 230 460 575	25.4	28.0	53.4	135
15	3	300L15	S13970	1	230	33.1	32.5	65.6	181
			S13978 S13971 S13972 *S13979	3	200 230 460 575	28.0	32.5	60.5	155

HP	Stages	W.E. Order No.	Motor Order No.	PH	Motor Volts	Motor Length	W.E. Length	L.O.A.	Wt. (lbs.)
20	5	300L20	S14978 S14971 S14972 *S14979	3	200 230 460 575	30.6	41.6	72.2	181
25	6	300L25	S15978 S15971 S15972 *S15979	3	200 230 460 575	33.1	45.8	78.9	200
30	7	300L30	S16978 S16971 S16972 *S16979	3	200 230 460 575	35.7	50.1	85.8	219
40	10	300L40	S17972 *S17979	3	460 575	40.8	63.4	104.2	269

DISCHARGE 3" NPT



(All dimensions are in inches and weights in lbs. Do not use for construction purposes.)
*Non-stock motors have a six (6) week lead time.

Water end and motor must be ordered separately and are packaged separately.

D-4

SELECTION CHART

Horsepower Range 5 – 40, Recommended Range 100 – 450 GPM, 60 Hz, 3450 RPM

Pump Model	Depth to Water in Feet/Ratings in GPM (Gallons per Minute)																	
	HP	PSI	10	25	50	75	100	125	150	175	200	250	300	350	400	450	500	550
300L05 1 Stage	5	0		410	180													
		20	160															
		30																
		40																
		50																
		60																
300L10 2 Stages	10	0			390													
		20	380	300	205													
		30	270	205	100													
		40	150	100														
		50	100															
		60																
300L15 3 Stages	15	0			440	390	330	270	200	100								
		20		400	340	280	215	120										
		30		340	285	215	120											
		40		290	218	140												
		50		220	140													
		60		142														
300L20 5 Stages	20	0				450	420	390	355	320	280	195						
		20		455	425	395	363	327	292	250	205							
		30		425	395	363	327	293	250	205	155							
		40		395	363	327	295	253	208	158								
		50		365	328	295	255	210	160									
		60		330	300	260	220	165										
300L25 6 Stages	25	0				465	440	415	388	360	330	270	183					
		20			445	420	395	365	355	307	275	198						
		30		445	420	397	365	337	309	275	240							
		40		422	398	367	340	310	276	242	208							
		50		400	370	343	312	280	245	210	165							
		60		373	345	315	283	248	212	168	123							
300L30 7 Stages	30	0				485	450	435	410	387	362	312	255	185	112			
		20				438	415	393	365	343	317	260	200	110				
		30			438	416	393	368	345	318	292	235	165					
		40		440	418	395	370	347	321	294	365	200	115					
		50		420	398	373	349	323	296	268	240	170						
		60		400	375	350	325	300	270	242	210	132						
300L40 10 Stages	40	0							450	433	420	388	353	320	280	240	192	140
		20						438	422	405	393	355	303	282	243	195	143	
		30					438	422	406	393	373	340	308	264	220	172	115	
		40				440	425	408	393	374	360	323	288	245	200	150		
		50			441	427	410	395	375	361	342	308	268	225	178	110		
		60		442	428	411	397	378	362	345	328	290	250	204	157			

D-5

Pump Fundamentals
PumpSmart®
Customer Service
Polyshield®

By Market
By Applic./Pump Type
By Model No./Name

Quick Links To:

Specifications

Design Features

Services

Performance Curves

Product Views and Construction

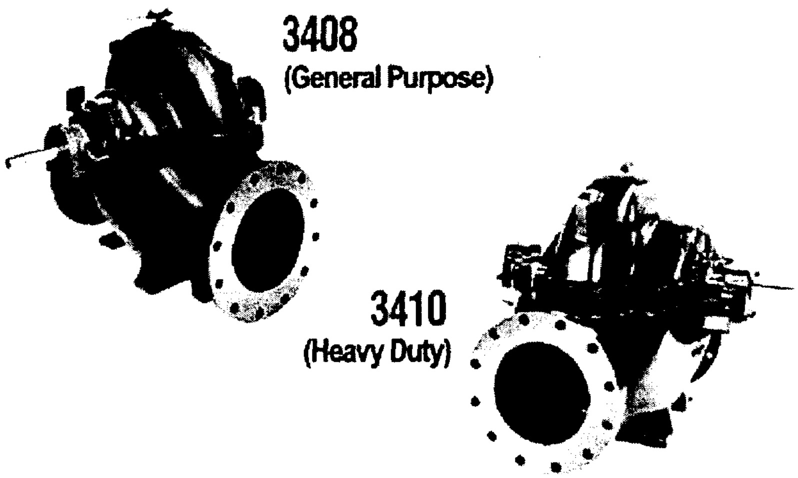
Home

3408 & 3410

Pumps / By Model Number/Product Name /

P-3

Models 3408 & 3410



Small Capacity, Single Stage, Double Suction Pumps Designed for a Wide Range of Industrial, Municipal, and Marine Services

Specifications go to top

- Capacities to 8,000 GPM
  (1817 m^3/h)
- Heads to 570 Ft. (174 m)
- Temperatures to 350° F (177° C)
- Working Pressures to 400 PSI (2758 kPa)

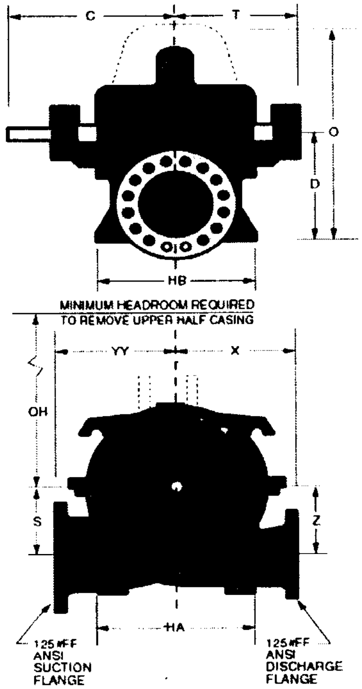
Design Features go to top

- **Horizontally Split Casing** In-line suction and discharge nozzles in lower half casing for ease of inspection/maintenance.
- **Double Suction Impeller** Assures Hydraulic Axial Balance for lower thrust bearing loads, longer pump life, and lower maintenence.
- **Dual Volute Casing** Assures Radial Balance for lower radial bearing oads, longer pump life and lower maintenance. (Not available on 3408. Availability on 3410 is size dependent.)
- **Wear Rings** Easily replaceable wear rings renew running clearances and protect against impeller, casing wear. Overall cost of operation is minimized.

D-6

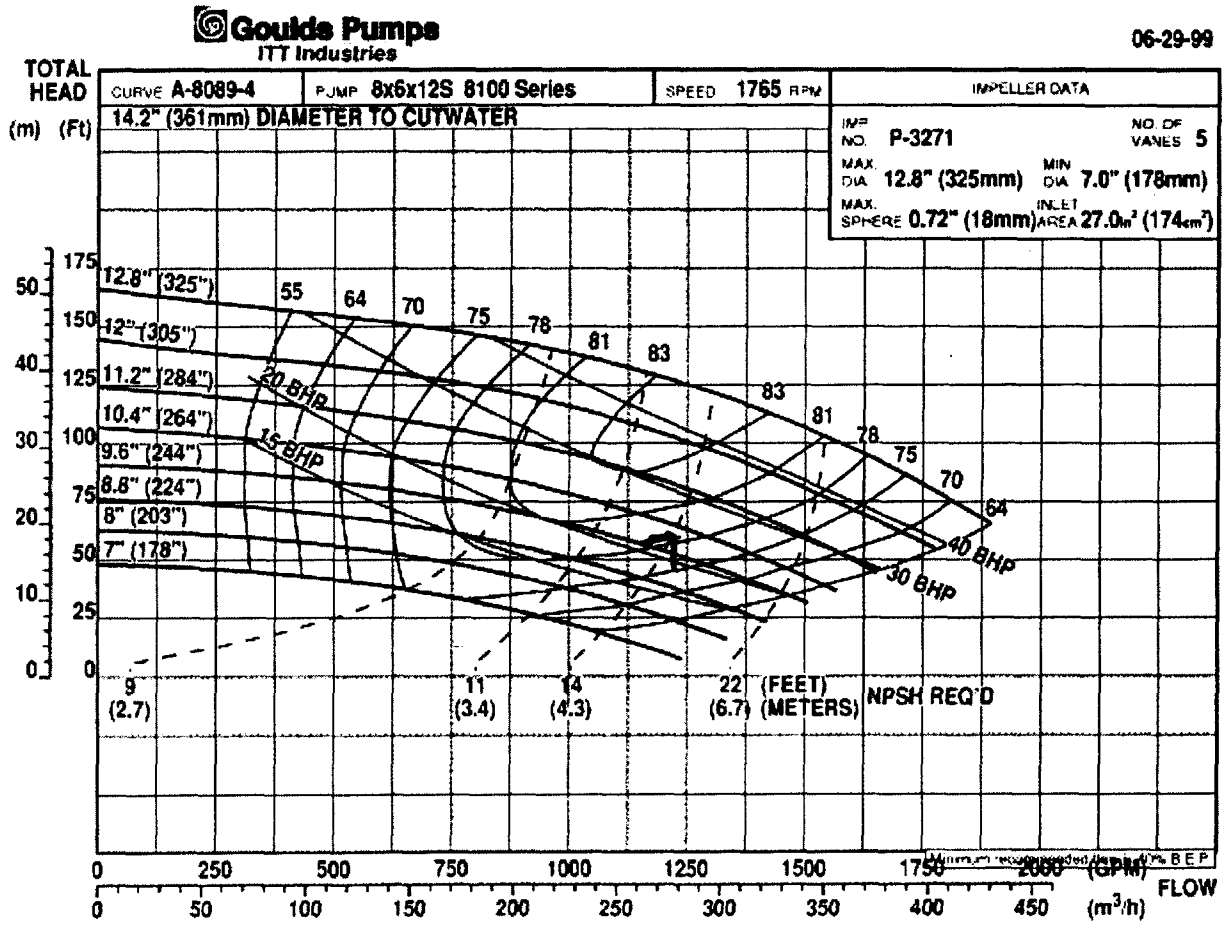
D-7

Dimensions



Frame Group	Pump Size	C	T	D	O	OH	S & Z	X	YY	HA	HB	Wt. Lbs (kg)
1A	2x3-11S/L	16.0 (406)	12.3 (311)	8.0 (203)	14.8 (376)	12.3 (312)	5.5 (140)	9.0 (229)	10.0 (254)	10.0 (254)	13.0 (330)	320 (145)
2A	4x6-9	17.3 (438)	12.8 (325)	11.0 (279)	18.7 (475)	12.6 (320)	7.0 (178)	11.5 (292)	12.0 (305)	13.5 (343)	15.0 (381)	445 (202)
	4x6-12S/M/L/XL	17.5 (445)	13.3 (337)	12.0 (305)	21.2 (538)	16.1 (409)	7.8 (197)	11.5 (292)	13.0 (330)	15.0 (381)	15.0 (381)	510 (231)
	4x6-14S/L	17.5 (445)	13.3 (337)	12.0 (305)	21.6 (549)	16.5 (420)	7.8 (197)	11.5 (292)	13.0 (330)	15.0 (381)	15.0 (381)	525 (238)
	6x6-9	17.3 (438)	12.8 (325)	11.0 (279)	19.2 (487)	13.1 (332)	7.0 (178)	11.5 (292)	13.0 (330)	13.5 (343)	15.0 (381)	480 (218)
	6x8-9	17.5 (445)	13.3 (337)	12.0 (305)	20.6 (524)	13.5 (343)	7.5 (191)	13.0 (330)	14.0 (356)	15.0 (381)	15.0 (381)	500 (227)
	6x8-12S/L/XL	17.5 (445)	13.3 (337)	14.0 (356)	23.6 (599)	16.3 (414)	9.0 (229)	14.0 (356)	14.0 (356)	15.0 (381)	15.0 (381)	640 (290)
2B	4x6-10S/M/L/XL	18.5 (470)	14.6 (371)	11.0 (279)	18.9 (480)	13.9 (353)	6.5 (165)	11.5 (292)	13.0 (330)	15.0 (381)	15.0 (381)	505 (229)
	4x6-11	18.5 (470)	14.6 (371)	11.0 (279)	19.6 (497)	14.4 (365)	7.4 (187)	11.5 (292)	13.0 (330)	15.0 (381)	15.0 (381)	540 (245)
	6x8-10	18.5 (470)	14.6 (371)	14.0 (356)	22.9 (581)	13.9 (353)	7.8 (197)	11.5 (292)	15.0 (381)	15.0 (381)	15.0 (381)	540 (245)
	6x8-12M	18.5 (470)	14.6 (371)	14.0 (356)	23.6 (599)	16.0 (406)	9.0 (229)	14.0 (356)	14.0 (356)	15.0 (381)	15.0 (381)	655 (297)
3A	6x8-13	21.3 (540)	15.6 (397)	12.8 (324)	22.2 (563)	16.0 (405)	8.0 (203)	13.0 (330)	15.5 (394)	16.3 (413)	18.5 (470)	675 (306)
	6x8-17M/L	21.3 (540)	15.6 (397)	14.0 (356)	25.8 (654)	20.3 (514)	9.0 (229)	14.0 (356)	16.0 (406)	16.3 (413)	18.5 (470)	755 (342)
	6x8-18	21.3 (540)	15.6 (397)	14.0 (356)	25.8 (654)	20.4 (517)	9.0 (229)	14.0 (356)	16.0 (406)	16.3 (413)	18.5 (470)	735 (333)
	8x8-12	21.3 (540)	15.6 (397)	12.8 (324)	24.5 (622)	18.2 (461)	8.0 (203)	14.0 (356)	16.5 (419)	16.3 (413)	18.5 (470)	725 (329)
	8x8-17	22.6 (573)	17.0 (432)	14.5 (368)	28.0 (711)	22.4 (568)	9.5 (241)	15.0 (381)	16.5 (419)	18.0 (457)	20.0 (508)	895 (406)
	8x10-12S/L	22.6 (573)	17.0 (432)	14.3 (362)	26.3 (667)	18.4 (467)	8.5 (216)	14.0 (356)	17.0 (432)	18.0 (457)	20.0 (508)	970 (440)
	8x10-17S/L	22.6 (573)	17.0 (432)	16.0 (406)	30.3 (770)	23.2 (588)	10.0 (254)	16.0 (406)	18.0 (457)	18.0 (457)	20.0 (508)	1030 (467)
	8x10-20S/L	22.6 (573)	17.0 (432)	20.0 (508)	42.3 (1073)	32.4 (822)	14.0 (356)	18.0 (457)	20.0 (508)	20.0 (508)	22.0 (559)	1410 (640)
	10x10-12	24.1 (611)	18.5 (470)	14.8 (375)	25.9 (659)	17.6 (447)	9.0 (229)	16.0 (406)	18.0 (457)	18.0 (457)	22.0 (559)	1040 (472)
	10x12-12M/XL	24.1 (611)	18.5 (470)	16.8 (425)	28.3 (718)	18.3 (464)	10.0 (254)	16.0 (406)	19.0 (483)	18.0 (457)	22.0 (559)	1040 (472)
	10x12-14	22.6 (573)	17.0 (432)	18.0 (457)	32.9 (837)	21.9 (557)	11.0 (279)	18.0 (457)	20.0 (508)	18.0 (457)	20.0 (508)	1150 (522)
	10x12-17	22.6 (573)	17.0 (432)	18.0 (457)	32.9 (837)	23.7 (602)	11.0 (279)	18.0 (457)	20.0 (508)	18.0 (457)	20.0 (508)	1160 (526)
	10x12-18	22.6 (573)	17.0 (432)	18.0 (457)	32.9 (837)	23.9 (608)	11.0 (279)	18.0 (457)	20.0 (508)	18.0 (457)	20.0 (508)	1095 (497)

All dimensions are in inches (mm) and are not to be used for construction or installation purposes.
Standard rotation is right hand (CW). Optional rotation is left hand (CCW).

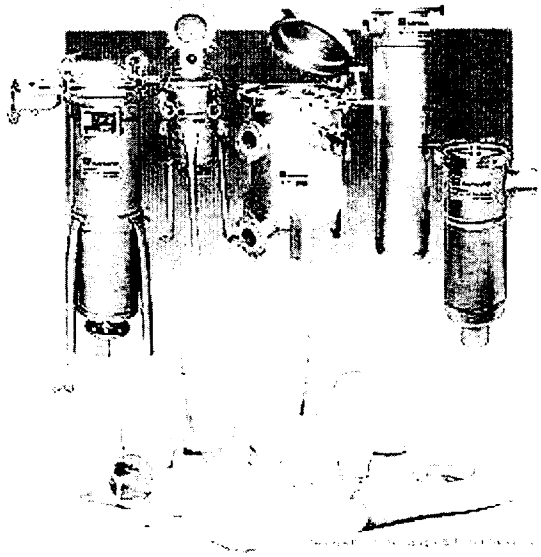

Goulds Pumps
ITT Industries
06-29-99
TOTAL HEAD
(m) (Ft)
CURVE A-8089-4
PUMP 8x6x12S 8100 Series
SPEED 1765 RPM
IMPELLER DATA
14.2" (361mm) DIAMETER TO CUTWATER
IMP NO. P-3271
NO. OF VANES 5
MAX. DIA 12.8" (325mm)
MIN DIA 7.0" (178mm)
MAX. SPHERE 0.72" (18mm)
INLET AREA 27.0in² (174cm²)
12.8" (325")
12" (305")
11.2" (284")
10.4" (264")
9.6" (244")
8.8" (224")
8" (203")
7" (178")
55 64 70 75 78 81 83
83 81 78 75 70 64
20 BHP
15 BHP
40 BHP
30 BHP
9 (2.7)
11 (3.4)
14 (4.3)
22 (6.7) (FEET) (METERS)
NPSH REQ'D
FLOW
(GPM)
(m³/h)

D-8

HAYWARD®

manufac

Filter



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Filter Bags

Find the right Filter Bag for your application

Filter Ve

Find the right your applicati

Play Video

Choose Speed
28K · 56K

MAXILINE Video

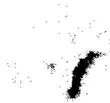
The quickest opening cover of any multi-bag vessel—only 15 seconds for reduced downtime between bag changes

Ask Haywa

Email us your questions. Fil special sts are you at no extr

Request a Catalog

Request a hard copy catalog from Hayward about the Filter and Filter Media products



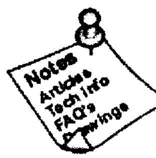
Hayward W

Locate a Sale area

You maximize the benefits of your filtration expenditure when you invest in a Hayward Filtration System. Hayward filter vessels and matching filter bags will always give you the reliable, consistent filtration performance you want, at the cost effective price you require. Explore the possibilities...

Hayward Home Page

Other Hayward Products viz. Metal Pipeline Strainers, Flowmeters, Gas/Liquid Separators & Plastic Valves



Library

For a wealth c Information, A Asked Questi much much m

D-9

Manufacturers of

HAYWARD®
Hayward Industrial Products, Inc.

LOEFFLER® FILTRATION | GAF Filter SYSTEMS

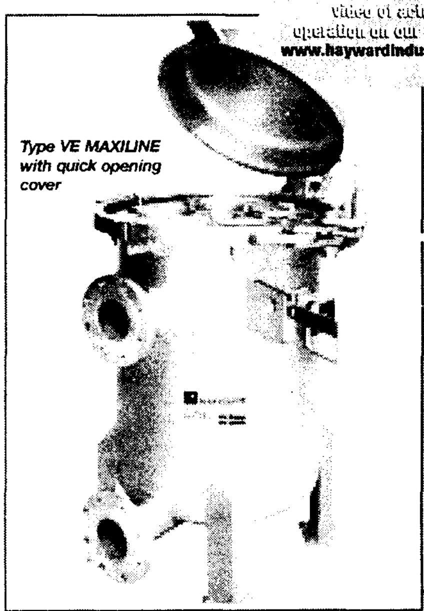
MAXILINE™ Filter Vessels

Multi-Bag, ASME Code Stamped Filter Vessel for High Flow Rate Applications up to 4500 gpm

Carbon or stainless steel construction with a choice of five different designs for maximum versatility:

- **MAXILINE Type VE** features a quick opening, spring assisted, hinged cover with a low profile design and integral venting.
- **MAXILINE Type HE** has a spring assisted, hinged cover for easy opening and closing, and has a low profile design.
- For those requiring a davit opening cover, **MAXILINE** offers two choices: the **Type HD** with a hand wheel and the **Type HA** with hydraulic assist. Both types feature a low profile design.
- For cost sensitive applications there is the **MAXILINE Type SEMB** with a hand wheel davit cover and a side inlet and outlet.

See video of actual operation on our website **www.haywardindustrial.com**



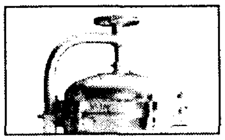
Type VE MAXILINE with quick opening cover

Value Added Features

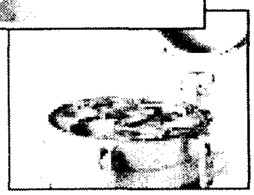
- **Stainless steel restrainer baskets**
- **Buna N™ seals**
- **Integral installation support legs**
- **Bag hold-downs included**
- **Choose vessels with from 3 to 24 bags**
- **ASME code stamp**
- **Choice of Type 316 stainless or carbon steel construction**
- **Raised face flanged, 150-lb ANSI piping connections**
- **Choice of five different designs for application flexibility**
- **Zinc-plated steel fasteners**

Available Options

- **Type 304 stainless steel construction**
- **Offset piping connections**
- **Pressure ratings above 150 psi**
- **Hydraulically-operated hinged cover**



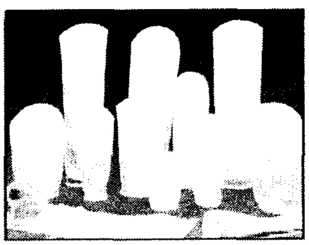
Type HD MAXILINE with davit cover



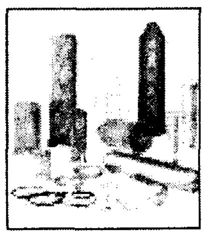
Type HE MAXILINE has spring-assisted hinged cover

Filter Bags and Useful Accessories for MAXILINE Filter Vessels

Your MAXILINE will perform best with precision filter bags from Hayward. There's one that's right for your application. Pick from polypropylene, polyester, nylon, Nomex or other felt or mesh fabrics in sewn or welded construction with micron ratings from 1 to 800. Ring seals include plastic or metal and, for unique applications, custom bags can be made. See pages 22 through 31 for all the details.



Improve your operation with the right MAXILINE accessory. **Displacement balloons** inside filter bags displace process media, make bag changes easier and minimize product loss. **Bag positioners** prevent the filter bag from shifting inside the vessel due to sudden pressure changes. **Magnetic inserts** trap ferrous particles and extend filter bag life. **Pressure gauges** can be used to monitor pressure differential to optimize time between bag changes. **Air vents** vent air into the vessel for easy access. **Elastomer seals** are available in Viton®, EPDM, PTFE and PTFE-encapsulated Viton®. See pages 20 & 21.



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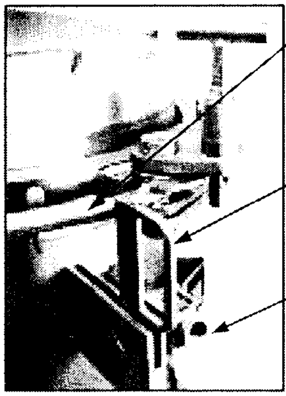
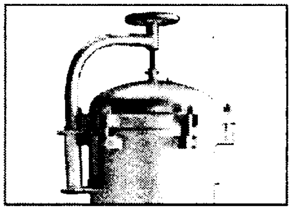
Take a Closer Look...

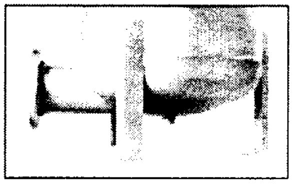
at MAXILINE™ Filter Vessels



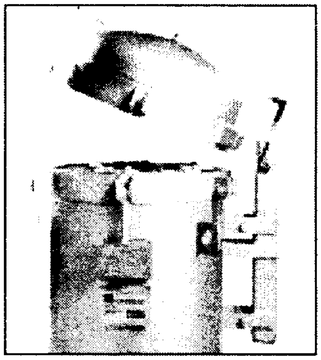
Integral Venting Design
MAXILINE's Type VE cover design prevents the cover from being opened until the vessel has been properly vented by moving the vent control handle down. Then the cover operating lever can be swung forward to open the cover.



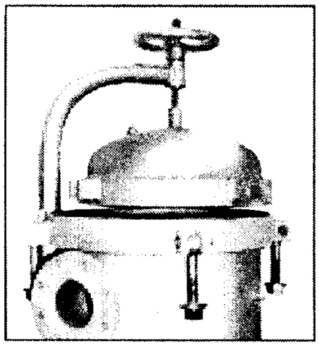
Type HD with handwheel operated davit cover. Also available with hydraulically-operated davit cover.



Low profile option. Standard operating height is reduced to allow for easy bag changeout. There's no need for platforms or ladders.



Type HE has hinged cover with spring assist and automatic stop. Loosen the swing bolt and simply lift up the cover to open it.



Type SEMB has economical handwheel operated davit cover—and includes side inlet and outlet.

MAXILINE Engineering Specifications

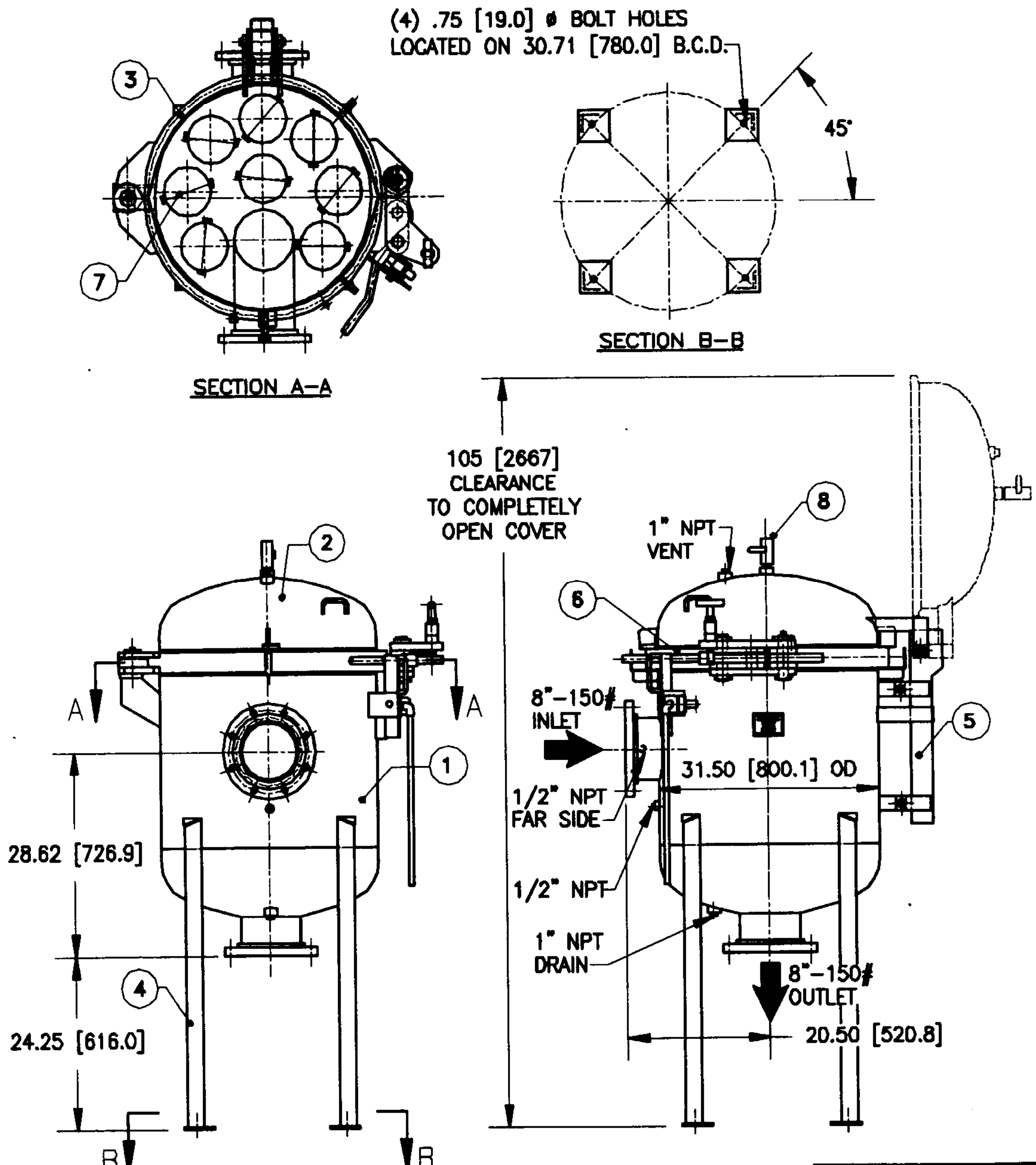
Filter Bag Size	3 to 24 #02 bags
Maximum Operating Pressure	150 psi
Maximum Operating Temperature	400F with Viton
Number of Seals	1
Material of Construction	SS 316 or CS
Surface Finish	SS-Bead blasted, CS-painted
Non-Wetted Parts	Zinc-plated steel
Code Stamp	ASME Section VIII Div. 1, "U" stamp
Seal Material	Buna N™ (Max. 250F)

MAXILINE Technical Data

No. of Bags	Max Water Flow (gpm)*	Filter Area (sq ft)**	Inlet/Outlet Size (in)***	Available Type
3	230	13.5	**3**	HD, HA, HE
4	400	18	**4**, 3	VE, HE, HD, SEMB, HA
6	900	27	**6**, 4, 8	VE, HE, HD, SEMB, HA
8	1750	36	**8**, 6. 4	VE, HE, HD, SEMB, HA
10	2600	45	**10**, 8, 6	HD, HA
12	2600	54	**10**, 8, 6	HD, HA
14	2600	63	**10**, 8, 6	HD, HA
16	3500	72	**12**, 10, 8	HD, HA
18	3500	81	**12**, 10, 8	HD, HA
20	4500	90	**14**, 12, 10	HD, HA
22	4500	99	**14**, 12, 10	HD, HA
24	4500	108	**14**, 12, 10	HD, HA

*Pressure differential and other factors can affect flow rate. Max. flow is without bags at 10 fps pipe velocity **4.5 sq ft per bag. ***Boldface number is standard.

D-11



ITEM	PART NAME	MATERIAL
1	BODY	SA240-316/316L
2	COVER	SA240-316/316L
3	O-RING	BUNA-N
4	LEGS	SA479-304L
5	SPRING ASSISTED MECHANISM	–
6	CLAMP ASSEMBLY	STAINLESS STEEL
7	FILTER BAG HOLD DOWN	316 SS
8	1" VENT VALVE	316 SS

NOTES:

1. UNITS ARE DESIGNED, FABRICATED & U STAMPED IN ACCORDANCE WITH ASME SECT. VIII, DIV. 1 BOILER & PRESSURE VESSEL CODE, IN COMPLIANCE TO LATEST ADDENDA.
2. INLET/OUTLET FLANGE CONNECTIONS PER ANSI B16.5
3. DESIGN PRESSURE: 150 PSIG @ 250°F (10.3 BAR @ 121.1°C)
4. ALL DIMENSIONS ARE IN INCHES / [mm]
5. ALL BOLT HOLES STRADDLE NATURAL CENTERLINE.
6. APPROX. WEIGHT (DRY): 1023 lbs. (465 kg.)

CERTIFIED FOR:

P.O. NO.:

REG. NO.:

QUOTE NO.:

TAG NO.:

HAYWARD PART NO.: MBF0812SB08FSV

D-12

HAYWARD INDUSTRIAL PRODUCTS, INC.
Manufacturer of LOEFFLER FILTRATION & GAF® FILTER SYSTEMS
900 FAIRMOUNT AVENUE, ELIZABETH, NEW JERSEY 07207

NAME: 8"-MBF-812 FILTER VESSEL 8"-150# INLET/OUTLET WITH BOTTOM OUTLET

DRAWN	FG	DATE	8/24/99	CERT.	WB	DATE	8/24/99

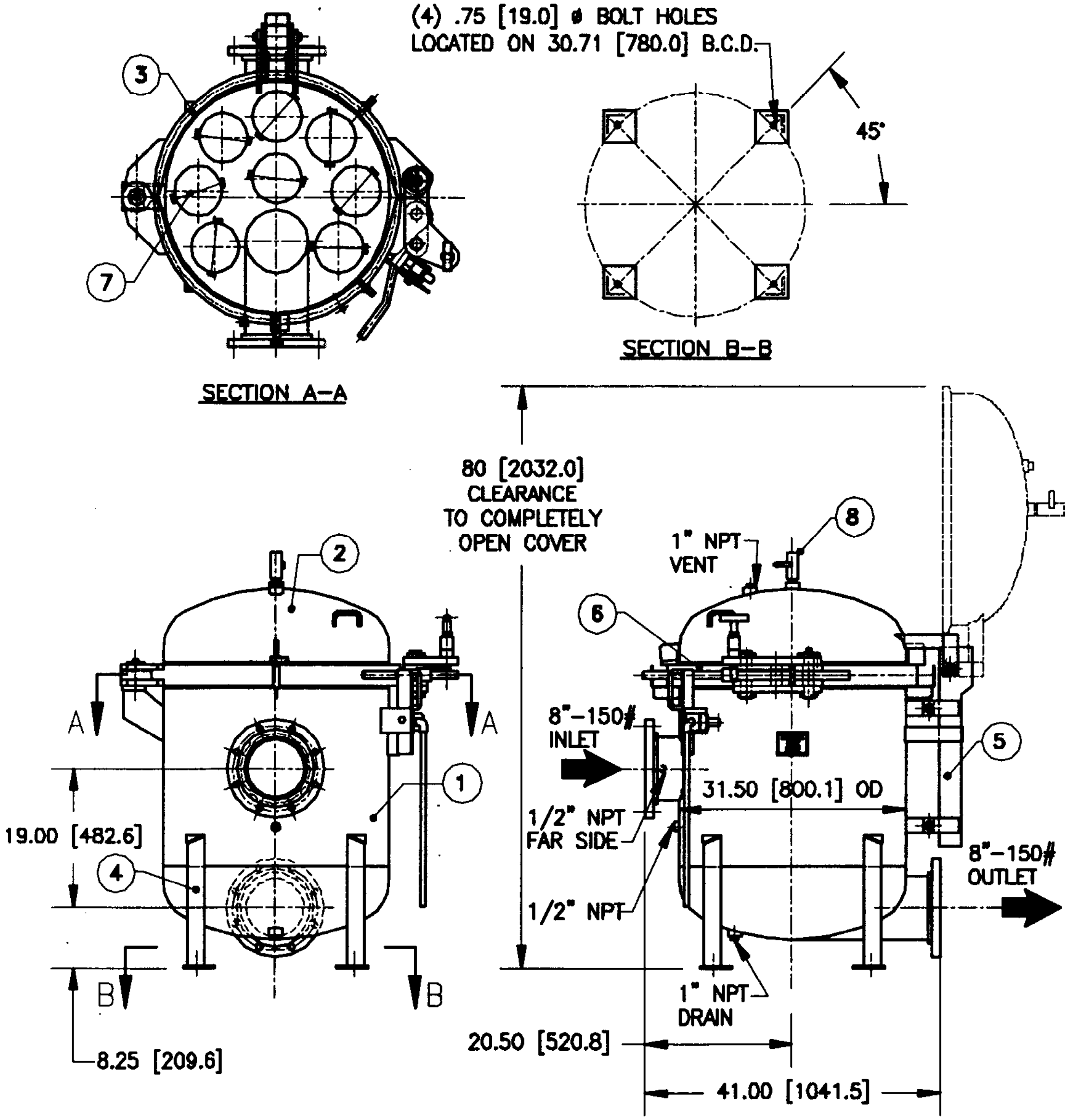
SIZE	DWG NO	REV
A	MBF08SV	C

ELECTRONIC FILE NAME: MBF08SV

REF. ECR	7822	DATE	8/24/99

REV 8/00

D-13



ITEM	PART NAME	MATERIAL
1	BODY	SA240-316/316L
2	COVER	SA240-316/316L
3	O-RING	BUNA-N
4	LEGS	SA479-304L
5	SPRING ASSISTED MECHANISM	-
6	CLAMP ASSEMBLY	STAINLESS STEEL
7	FILTER BAG HOLD DOWN	316 SS
8	1" VENT VALVE	316 SS

NOTES:

1. UNITS ARE DESIGNED, FABRICATED & U STAMPED IN ACCORDANCE WITH ASME SECT. VIII, DIV. 1 BOILER & PRESSURE VESSEL CODE, IN COMPLIANCE TO LATEST ADDENDA.
2. INLET/OUTLET FLANGE CONNECTIONS PER ANSI B16.5
3. DESIGN PRESSURE: 150 PSIG @ 250°F (10.3 BAR @ 121.1°C)
4. ALL DIMENSIONS ARE IN INCHES / [mm]
5. ALL BOLT HOLES STRADDLE NATURAL CENTERLINE.
6. APPROX. WEIGHT (DRY): 1023 lbs. (465 kg.)

CERTIFIED FOR:
P.O. NO.:
REG. NO.:
QUOTE NO.:
TAG NO.:
HAYWARD PART NO.: MBF0812SB08FSV0

HAYWARD INDUSTRIAL PRODUCTS, INC.
Manufacturer of LOEFFLER FILTRATION & GAF® FILTER SYSTEMS
900 FAIRMOUNT AVENUE, ELIZABETH, NEW JERSEY 07207

NAME: 8"-MBF-812 FILTER VESSEL 8"-150# INLET/OUTLET WITH TANGENTIAL OUTLET

DRAWN FG | DATE 8/24/99 | CERT. WB | DATE 8/24/99

SIZE A | DWG NO MBF08SV0 | REV C

ELECTRONIC FILE NAME: MBF08SV0
REF. ECR 7822 | DATE 8/24/99

REV 8/00

HAYWARD®
Hayward Industrial Products, Inc.

Manufacturers of LOEFFLER FILTRATION GAF Filter SYSTEMS

Hayward Filter Bags

How to Order:

Example – **PO-10-P02S-H-50**

Bag Material		Micron Rating		Bag Cover	Bag Size	Collar		Options		Quantity (Bags /Box)
PO	–	10	–	P	02	S	–	H	–	50

Bag Material: Enter Code From Table Below

Bag Cover:
- **A** PEMU 150 Micron
- **E** Extruded Mesh Cover + PO Spunbond
- **P** Plain (No Cover)
- **T** PO Spunbonded Cover

Bag Size:
- **01** 7" Diameter x 17" Length
- **02** 7" Diameter x 32" Length
- **03** 4" Diameter x 8" Length
- **04** 4" Diameter x 14" Length
- **05** 4" Diameter x 20" Length
- **43** 3.5" Diameter x 12" Length
- **45** 3.5" Diameter x 20" Length

Collar:

SNAP-RING
- **A** Stainless Steel
- **B** Nylon
- **O** Polypropylene
- **S** Carbon Steel, Galvanized

SENTINEL®
- **E** Polypropylene
- **H** Polyester
- **Z** Santoprene

Tie-On Bag
- **R** Tie-on Bag (No Ring)

Options:
- **C** Reverse Collar
- **E** Twill Tape Reinforced Side and Bottom Seam
- **H** 1 Handle in Twill Tape
- **R** Draw String for Tie-on Bags
- **T** Mesh Bag with Twill Tape Collar
- **W** Welded Side and Bottom Only
- **WW** Fully Welded

Hayward Filter Bag Availability

Code	Material	Micron Rating															Construction Sewn/Welded	Type of Filtration	Media Rating
		1	5	10	25	50	75	80	100	150	200	250	300	400	600	800			
PO	Polypropylene	•	•	•	•	•			•		•						Sewn or Welded	Depth	Nominal
POXL	Polypropylene Extended Life	•	•	•	•	•			•								Sewn or Welded	Depth	Nominal
POF	Polypropylene - FDA	•	•	•	•												Welded	Depth	Nominal
POXLF	Polypropylene Extended Life - FDA	•	•	•													Welded	Depth	Nominal
PE	Polyester	•	•	•	•	•	•		•		•						Sewn or Welded	Depth	Nominal
PEXL	Polyester Extended Life	•	•	•	•	•			•								Sewn or Welded	Depth	Nominal
PEF	Polyester - FDA	•															Welded	Depth	Nominal
PEXLF	Polyester Extended Life - FDA	•	•	•													Welded	Depth	Nominal
NY	Nylon		•	•	•	•			•								Sewn	Depth	Nominal
HT	Nomex	•	•	•	•	•			•								Sewn	Depth	Nominal
PT	PTFE	•	•	•													Sewn	Depth	Nominal
NMO	Nylon Monofilament		•	•	•	•		•	•	•	•	•	•	•	•	•	Sewn	Surface	Absolute
PMO	Polypropylene Monofilament								•	•	•		•	•	•	•	Sewn	Surface	Absolute
PEMU	Polyester Multifilament								•	•	•	•	•	•	•	•	Sewn	Surface	Nominal
Oilex	Meltblown Polypropylene				•				•								Sewn	Adsorption	Nominal
PEMO	Polyester Monofilament					•		•		•	•			•			Sewn	Surface	Absolute
PTMO	PTFE Monofilament								•	•	•	•		•	•		Sewn	Surface	Absolute
ABP	Accurate Meltblown Polypropylene	•	•	•	•												Welded	Depth	Absolute
		Efficiency Rating																	
AGF	Polypropylene Meltblown	51, 53, 55, 57, 59															Welded	Depth	Absolute
PGF	Multilayer Meltblown Polypropylene	51, 55															Welded	Depth	Absolute
MBP	Meltblown Polypropylene	145															Sewn	Adsorption	Nominal

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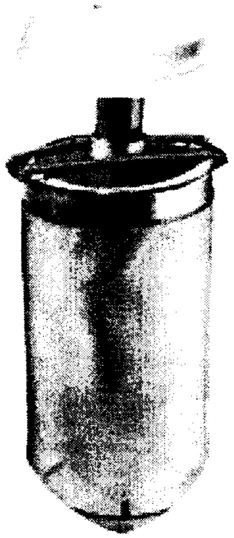
Take a Closer Look...

at Hayward Filter Bags

Comparative Particle Size

U.S. Mesh	Inches	Microns	U.S. Mesh	Inches	Microns
3	0.265	6730	45	0.0138	354
3-1/2	0.223	5660	50	0.0017	297
4	0.187	4760	60	0.0098	250
5	0.157	4000	70	0.0083	210
6	0.132	3360	80	0.0070	177
7	0.111	2830	100	0.0059	149
8	0.0937	2380	120	0.0049	125
9	0.0787	2000	140	0.0041	105
10	0.0661	1880	170	0.0035	88
12	0.0555	1410	200	0.0029	74
14	0.0469	1190	230	0.0024	63
18	0.0394	1000	270	0.0021	53
20	0.0331	841	325	0.0017	44
25	0.0280	707	400	0.0015	37
30	0.0232	595	550	0.0009	25
35	0.0197	500	800	0.0006	15
40	0.0105	420	1250	0.0004	10



Adapter Head and Basket

Used in conjunction with SNAP-RING Filter Bags in gravity feed open systems. Adapter heads are available in 316 SS and polypropylene with 1.5" or 2" NPT. No support basket is required for pressures to 10 psi. Above that, to 20 psi maximum, a basket support is recommended.

Filter Bag Specifications

Bag Size	Max. Flow Water (gpm)	Flow Area (sq. ft.)	Volume (gal.)	Diameter (in.)	Length (in.)
01	90	2.6	2.0	7	17
02	180	5.0	4.5	7	32
03	25	0.8	0.5	4	8
04	50	1.5	0.7	4	14
05	75	2.1	1.0	4	20
43	25	1.0	0.8	3.5	12
45	50	1.6	1.2	3.5	20

Chemical & Thermal Resistance of Filter Bags

Filter Media	Abbreviation	Temp. °F	Temp. °C	Aqueous Media	Aliphatic Solvents	Aromatic Solvents	Alkaline Systems	Strongly Alkaline	Acid Systems	Strongly Acidic
Polypropylene Felt	PO/POXL/POF/POXLF	200	93	•	•		•		•	•
Polyester Felt	PE/PEXL/PEF/PEXLF	300	149	•	•	•	•		•	
Nylon Felt	NY	325	163	•	•	•	•	•		
High Temp. Nomex Felt	HT	400	204	•	•	•	•		•	
Polyester Multifilament	PEMU	300	149	•	•	•	•		•	
Polypropylene Monofilament	PMO	200	93	•	•		•		•	
Nylon Monofilament	NMO	325	183	•	•	•	•	•		
PTFE	PT	500	260	•	•	•	•	•	•	

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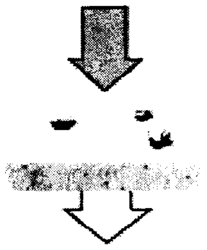
Take a Closer Look...

Hayward Filter Bag Media

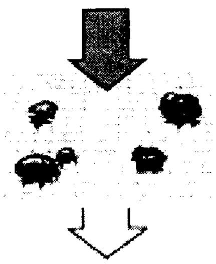


Depth Filtration

FELTS- Operating on the principle of depth filtration, needled felt filter bags are effective at removing both solid and gelatinous particles. 100% pure fibers are needled to create a tortuous path in a three-dimensional medium. Materials available are polypropylene, polyester, nylon, PTFE and Nomex.

Felt Advantages Include:

- High dirt holding capacity
- Capability to remove gelatinous particles
- Cost-effective filtration due to long service life



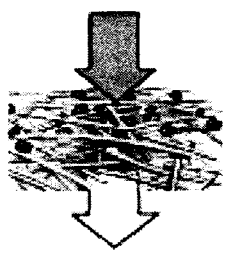
Surface Filtration

MULTIFILAMENT MESH- Operating on the principle of surface filtration, multifilament mesh filter bags are manufactured from mesh material in which each strand consists of hundreds of thin interwoven fibers. *The multifilaments are woven in a specific, consistent pattern. Multifilament meshes offer the low-*est unit cost in filter bags. They are available in polyester with micron ratings from 100 to 800 microns.

MONOFILAMENT MESH- Also operating on the principle of surface filtration, monofilament mesh filter bags are manufactured from mesh materials in which each strand is a single filament. The non-deformable filaments are woven in a specific, consistent pattern and fusion welded for extra strength. Monofilament meshes are structurally very strong and are available in both nylon and polypropylene with micron ratings from 5 to 800.

Monofilament Mesh Advantages Include:

- Absolute rated medium
- High mechanical strength

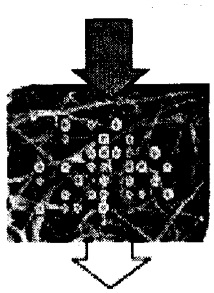


Adsorption Technology

OIL ADSORPTION- Manufactured from a combination of polypropylene felt, meltblown polypropylene and a protective polyester mesh cover, the oil adsorption filter bag series is designed to remove oils and hydrocarbon liquids from aqueous fluids, while providing the benefits of particle retention.

Oil Adsorption Advantages Include:

- Unparalleled adsorption characteristics for oils and hydrocarbons
- Higher flow rates
- Superior levels of adsorption efficiency via controlled flow velocity



Meltblown Polymers

MELTBLOWN POLYMERS- High efficiency ACCUGAF™ and PROGAF™ series filter bags are available in polypropylene meltblown materials. These filter bags are manufactured with welded seams and utilize the patented bypass-proof SENTINEL® seal ring in order to maintain the high efficiency of the meltblown material in the bag configuration.

ACCUGAF™ and PROGAF™ series bags offer high efficiency filter media with graded density profile to maximize dirt holding capacity and prolong service life. Both bags are manufactured from materials that are compliant with FDA standards for food, beverage and pharmaceutical applications.

D-16

Proposal Number:
RP# 1102-09B

Hartzell FAN, INC.®
910 S. DOWNING ST.
P.O. BOX 919
PIQUA, OHIO 45356-0919 U.S.A.

Duns No.
05-655-1039

YOUR INQUIRY	DATE OF INQUIRY	DATE OF PROPOSAL	DATE PROPOSAL EXPIRES
NWIRP Groundwater Treatment	11/11/02	11/11/02	12/11/02

THIS PROPOSAL VALID FOR 30 DAYS UNLESS OTHERWISE NOTED

TO Jean-Luc Glorieux
Tetra Tech NUS
661 Andersen Drive
Foster Plaza 7
Pittsburgh, PA 15220
Attention: Jean-Luc Glorieux

Phone: 412-921-8568
Fax: 412-921-4040
e-Mail:

PROPOSAL

Tag Item	Quantity	Desc..ption	Lot Price (USD)
	1	A05-9-292AH100STFCR3	
Revised Duty		05 - Industrial Exhausters Fan, Single Width Volume Flow Rate: 7,350 cfm Static Pressure: 18.00 in wg Density: 0.075 lbs/ft^3 Operating Temperature: 70 F Fan RPM: 1,972 RPM Standard Power: 29.38 hp Operating Power: 29.38 hp Arrangement: 9 Size: 29 Blade/Wheel Type: AH Rotation/Discharge: Clockwise - Top Horizontal Material: Steel Motor HorsePower: 30 Motor Enclosure: TEFC, 1.15 S.F. Motor RPM/Volt/Phase: 1750/230-460/3 Motor Voltage Required: 460 AMCA Certified for Air Performance Performance ratings [BHP] exclude drive losses	
	1	Fixed Drive RPM:1972, HP: 30 (Mult Groove) Nom. 1800 RPM Motor	
	1	Arr. #9 Belt Guard (Steel) Nominal Fan Size 29"	
	1	Drain (Steel) Nominal Fan Size 29"	
	1	Bolted Access Door (Steel Nominal Fan Size 29"	
	1	Inlet Flange (Steel) Nominal Fan Size 29"	
	1	Drilling of Inlet Flange Nominal Fan Size 29"	
	1	Drilling of Outlet Flange Nominal Fan Size 29"	

Tag Item Total:

SHIP VIA:

Proposal Total: **3,993.00**

The proposed fan is based on being a production unit. However, this model is also available from Hartzell's HRS stock program if the availabe accessories match your requirements. A page is attached showing the accessories available in the stock program.

Lead Time: 5-6 Weeks ARO (SUBJECT TO CONFIRMATION AT TIME OF ACCEPTANCE)
FOB Shipping Point
Payment Terms: Net 30 Days with Approved Credit

IMPORTANT NOTICE PLEASE READ

The safe application and use of equipment supplied by Hartzell Fan, Inc.® is the responsibility of the installer, user, owner, and employer. To evaluate the safe application of this equipment, the following should be considered: the location of the installation, accessibility of employees and other persons to the equipment, and adjacent equipment, applicable building and safety codes, and requirements of OSHA.

****

Since the application and use of its equipment can vary greatly, Hartzell Fan, Inc.® offers various product types, optional safety accessories, and sound performance data per laboratory tests. An industry publication. "Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans" is available from Hartzell upon request.

This proposal prepared by and any resulting purchase orders are to be sent to:

Hartzell Fan Inc., In Care Of
Rice Pittsburgh Co., Inc.
109 West Eugene Avenue
Munhall, PA 15120
Phone: (412)462-0200
Fax: (412)462-4408
e-Mail: ricepitt@aol.com

Thank You

Tim Kern /jo

Tim Kern
Rice Pittsburgh Co., Inc.

TERMS AND CONDITIONS OF SALE OF HARTZELL FAN, INC. ("HARTZELL")

These Terms and Conditions of Sale should be read carefully Sale of any goods or services described or referred to herein is subject to these Terms and Conditions of Sale Any order for or any statement of intent to purchase any goods or services, or any direction to proceed with engineering, procurement, manufacture or shipment, constitutes assent to these Terms and Conditions of Sale.

REJECTION OF DIFFERENT TERM - This document is not an acceptance of any prior written or oral offer. If any such prior written or oral offer has been made, it is hereby rejected. These Terms and Condition of Sale supersede any additional or different written or oral terms previously or subsequently communicated. Acceptance is expressly limited these Terms and Conditions of Sale. Hartzell hereby gives notification of its objection to and rejection of any proposed terms different from those contained herein whether municated previously or subsequently and whether written or oral This document is the complete and exclusive statement of the agreement between Hartzell and Buyer

LIVERY - Shipping dates are approximate and are based upon prompt receipt of all necessary information

Hartzell is not liable for delays in delivery or in performance or failure to manufacture or deliver, due to (1) causes beyond its reasonable control, including errors in manufacture or (2) acts of God, acts of the Buyer; acts of civil or military authority, priorities, fires, strikes, or other labor disturbances, floods, epidemics, war, riot, delays in transportation or car shortage, or (3) inability on account of causes beyond its reasonable control to obtain necessary labor, materials, components or manufacturing facilities. In the event of any such delay, the date of delivery or of performances shall be extended for a period equal to the time lost by reason of delay.

START-UP SERVICE - On certain equipment start-up service is available from Hartzell at per diem rates plus lodging and traveling expenses. Such start-up service is not included unless specifically quoted. There will be an additional charge for time used exceeding any number of days quoted.

ELECTRICAL EQUIPMENT - Equipment includes only the electrical components referred to in the proposal. Charges arising from any local, state, provincial or other regulations necessitating changes to electrical equipment will be paid by Buyer unless agreed otherwise in writing by Hartzell

CANCELLATION/TERMINATION/MODIFICATION - There can be no cancellation, termination or modification by Buyer without Hartzell's prior written consent.

CLAIMS - Claims of shortages or errors or other basis for rejection must be made within five (5) days after delivery.

PRICING - Prices quoted are firm provided release to manufacture and shipment is completed by Hartzell within six (6) months from the date of order entry If shipment is delayed for reasons beyond control of Hartzell and is not made within six (6) months from date of order entry, prices are subject to change at Hartzell's option.

PROPOSALS - Valid for 30 calendar days only.

PAYMENT TERMS

TAXES - Any tax or other governmental charge now or hereafter levied upon the reproduction, sale, use or shipment of goods ordered or sold will be charged to and paid for by Buyer. Such taxes are not included in Hartzell's price unless expressly so provided.

TERMS OF PAYMENT - Terms of payment are Net 30 days from the date of invoice. If shipment is delayed by the Buyer, date of readiness for shipment shall be deemed to be date of invoice for payment purposes. If, in Hartzell's judgment, the Buyer's financial condition at any time does not justify normal payment terms, Hartzell may require full or partial payment as a condition to commencing or continuing manufacture, or in advance of shipment, or, if shipment has been made, recover equipment from the carrier

FREIGHT - Unless otherwise stated, prices are F.O.B. shipping point

PRODUCT CHANGES - Factors beyond Hartzell's control and the need for continuing improvement of products require the making of changes in products from time to time Hartzell reserves the right to make reasonable changes in products without notice, and to deliver revised designs or models of products against any order, unless this right is specifically waived by it in writing

GOODS MANUFACTURED BY OTHERS - Hartzell has no responsibility whatever with respect to goods sold but not manufactured by Hartzell and Buyer's sole recourse is against the manufacturer of said goods Hartzell will assign to Buyer any pertinent warranty rights received by Hartzell from manufacturer.

PATENTS - Hartzell shall defend any suit or proceeding brought against the Buyer insofar as based on a claim that any goods sold by Hartzell, or any part thereof constitutes an infringement of any patent of the United States, if notified promptly in writing and given to authority, information and assistance for the defense of same, and Hartzell shall pay all damages and costs awarded therein against the Buyer In case said Hartzell goods, or any part thereof, is in such suit held to constitute infringement and the use of said goods is enjoined, Hartzell shall, at its own exp se and at its option, either procure for the Buyer the right to continue using said goods; or replace same with non-infringing equipment; or modify it so they become non-infringing, or remove said goods and refund purchase price and the transportation and installation costs thereof. The foregoing states the entire liability of Hartzell for patent infringement.

The preceding paragraph shall not apply to any goods or any part thereof not manufactured by Hartzell or to any goods or any part thereof, manufactured to Buyer's design, nor for any use to which any such goods may be put as a part of any system, mechanism or process covered by patent rights of others. As to such goods or any part thereof, Hartzell assumes no liability whatsoever for patent infringement.

LLECTUAL PROPERTY - The design, performance information, construction detail of Hartzell goods or any part thereof, is proprietary, and remains the valuable property of ell. Buyer agrees not to copy or duplicate the goods or any part thereof, or information related thereto provided without express written authorization from Hartzell.

ITED WARRANTIES - Hartzell represents to Buyer that any goods to be delivered hereunder will be produced in compliance with the requirements of the Fair Labor Standards Act of 1938 as amended.

Hartzell also warrants to Buyer its goods to be free from defects in workmanship and material under normal use and service for one (1) year after tender of delivery by Hartzell. No warranty extends to future performance of goods and any claims for breach of warranty or otherwise accrues upon tender of delivery.

The foregoing constitute Hartzell's sole and exclusive warranties and are in lieu of all other warranties, whether written, oral, express, implied or statutory.

LIMITATION OF LIABILITY FOR BREACH OF WARRANTY - Hartzell's obligation for any breach of warranty is limited to repairing or replacing, at its option, without cost to Buyer at its factory any goods which shall, within such a warranty period, be returned to it with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been defective. Any request for repair or replacement should be directed to Hartzell Fan, Inc., P.O. Box 919, Piqua, Ohio 45356. Hartzell will not pay for any repairs made outside its factory without its prior written consent. This does not apply to any such Hartzell goods which have failed as a result of faulty installation or abuse, or incorrect electrical connections or alterations, made by others, or use under abnormal operating conditions or misapplication of the goods.

LIMITATION OF LIABILITY - To the extent the above limitation of liability for breach of warranty is not applicable, the liability of Hartzell on any claim of any kind, including negligence, for any loss or damage arising out of or connected with, or resulting from the sale and purchase of the goods or services covered by these Terms and Conditions of Sale or from the performance or breach of any contract pertaining to such sale or purchase or from the design manufacture, sale, delivery, resale, installation, technical direction installation, inspection repair, operation or use of any goods or services covered by these Terms and Conditions shall, in no case exceed the price allocable to the goods or services which gave rise to the claim and shall terminate one year after tender of delivery of said goods or services

In no event whether as a result of breach of contract, or warranty or alleged negligence, defects, incorrect advice or other causes, shall Hartzell be liable for special or consequential damages, including, but not limited to, loss of profits or revenue, loss of use of the equipment or any associated equipment, cost of substitute equipment, facilities or services, down time costs, or claims of customers of the Buyer for such damages Hartzell neither assumes nor authorizes any person to assume for it any other liability in connection with the sale of its goods or services.

NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS - HARTZELL DOES NOT WARRANT THAT SAID GOODS ARE OF MERCHANTABLE QUALITY OR THAT THEY ARE FIT FOR ANY PARTICULAR PURPOSE. THERE IS NO IMPLIED WARRANTY OF MERCHANTABILITY AND THERE IS NO IMPLIED WARRANTY OF FITNESS

REGULATORY LAWS AND/OR STANDARD - Hartzell makes no promise or representation that its product will conform to any state or local laws, ordinances, regulations, codes or standards, except as particularly specified and agreed upon in writing. Hartzell's prices do not include the cost of any related inspection permits or inspection fees

EXCLUSIVE FORUM SELECTION CLAUSE - Any claims relating to these Terms and Conditions of Sale of the goods or services thereunder shall be brought (if subject matter jurisdiction exists) solely in the United States District Court for the Southern District of Ohio (Western Division) In the absence of subject matter jurisdiction in that Court, any such claims shall be brought solely in any C mon Pleas Court of the State of Ohio within the area encompassed by the United States District Court for the Southern District of Ohio (Western Division).

PAYMENT OF HARTZELL'S REASONABLE ATTORNEY'S FEES, EXPENSES AND COSTS - In the event of litigation relating to the goods or services referred to herein or any aspect of these Terms and Conditions of Sale, Buyer shall pay Hartzell's reasonable attorney's fees, expenses and costs.

NO DELEGATION - Buyer may not perform any duties under these Terms and Conditions of Sale through a delegate.

NO ASSIGNMENT - The rights of the Buyer hereunder cannot be assigned.

NO MODIFICATION, RESCISSION OR WAIVER - These Terms and Conditions of Sale are not subject to modification, rescission or waiver except by a writing signed by an officer of Hartzell.

NO THIRD PARTY BENEFICIARY - These Terms and Conditions of Sale are for the benefit of Hartzell and the Buyer and not for any other person

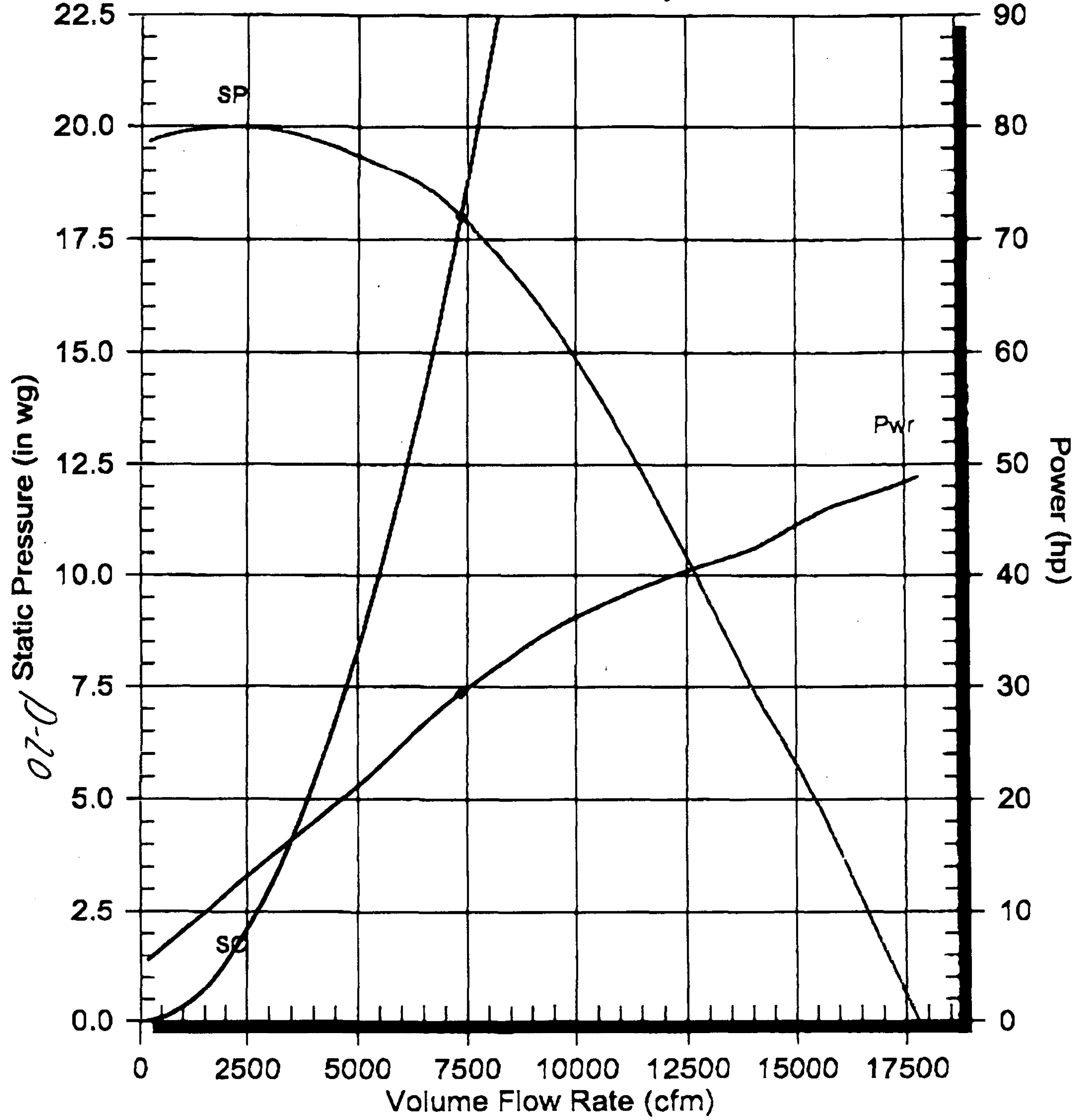
GENERAL - All proposals are made and all orders are accepted by Hartzell with the reference to the laws of the State of Ohio and the rights and duties of all persons and the ruction and effect all provisions thereof shall be governed by the construed according to the laws of the State of Ohio.

d any of these Terms and Conditions of Sale violate any or be involved under applicable law, the Terms and Conditions of Sale shall not fail by reason thereof but shall be construed in the same manner as such terms or conditions had not appeared herein.

01/25/1999 147699.4

Hartzell Fan, Inc.®

ESP - Version 1.6.99 - July, 2002



Date:	12/1/02
Job Ref:	NWIRP Groundv Treatment
Tag #:	Revised Duty
Proposal #:	RP# 1102-09
Rep. Name:	Rice Pittsburgh Company , Inc.
Phone #:	412-462-0200
Fax #:	412-462-4408

Fan Selected:

A05-9-292AH100STFCR3

05 - Industrial Exhausters Fan, Single Width

Vol Flow Rate	7350
Static Pressure	18.
Density	.075
Operating Temp	70 F
Fan RPM	1972
Max Safe RPM	2084
Operating Power	29.376
Standard Power	29.376
Static Efficiency	0.709
Outlet Velocity	4632

AMCA Licensed for Air Performance Only

Power level ratings [BHP] exclude drive losses

Discharge Sound Power Levels referred to 10^-12 watts

1	2	3	4	5	6	7	8
114	113	105	104	100	97	94	92

Sound Pressure 95 dBA @ 5.0 ft from fan acoustic source (Q=2)

Radiated Sound Power Levels referred to 10^-12 watts

1	2	3	4	5	6	7	8
103	101	92	90	84	80	78	75

Sound Pressure 80 dBA @ 5.0 ft from fan acoustic source (Q=2)

amca
CERTIFIED
RATINGS

AIR
PERFORMANCE

AIR
MOVEMENT
AND CONTROL
ASSOCIATION
INTERNATIONAL, INC.

10-21

tzell Fan, Inc. certifies that the model shown is licensed to bear the AMCA Seal.
: ratings shown are based on tests and procedures performed in accordance with AMCA publication 211 and comply with the requirements of the AMCA Certified Ratings Program.

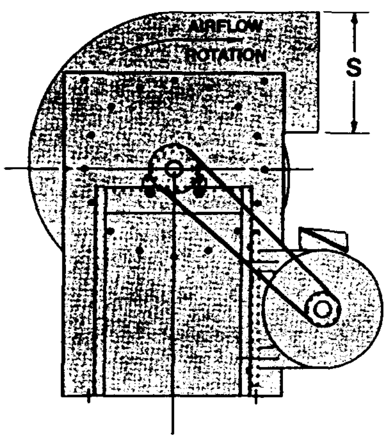
formance shown is for Installation Type D: Ducted Inlet, Ducted Outlet.
formance Ratings do not include the effects of appurtenances in the airstream.
ınd ratings are based on sound power level data obtained in accordance with AMCA standard 300.
: sound power level ratings shown are in decibels, referred to 10^-12 watts, calculated per AMCA Standard 301.
Outlet Sound Testing. Values shown are for outlet LwoA sound power levels for: Installation Type C: ducted inlet, ducted outlet. Ratings do not include the effects of duct end correction.

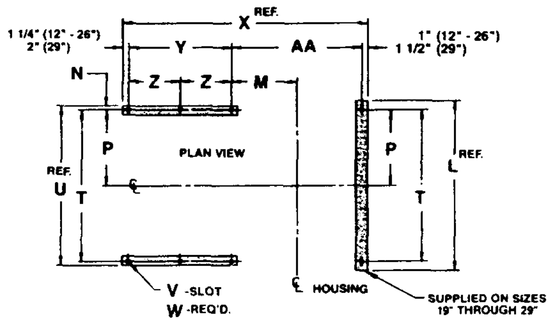
dBA values shown are calculations based on Hartzell laboratory tests, are not AMCA licensed, and may not be indicative of actual installation values.

Dimensions - Arrangements 1, 9 or 10

SERIES 05

Sizes 12 Through 29, Rotatable Housing

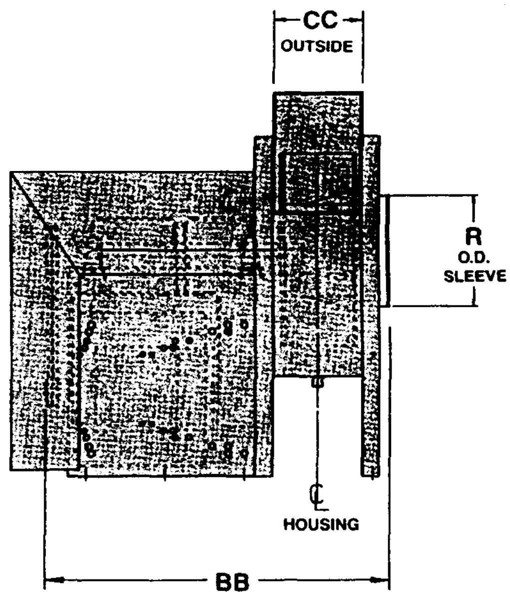




PLAN VIEW NOTES

An inlet support and the dimensions indicated by an asterisk (*) are not standard for sizes 12 and 15 except when vibration isolators are specified. All dimensions listed for 19 thru 29 are standard with or without vibration isolators.

Clockwise Rotation Shown.
Counterclockwise Opposite.



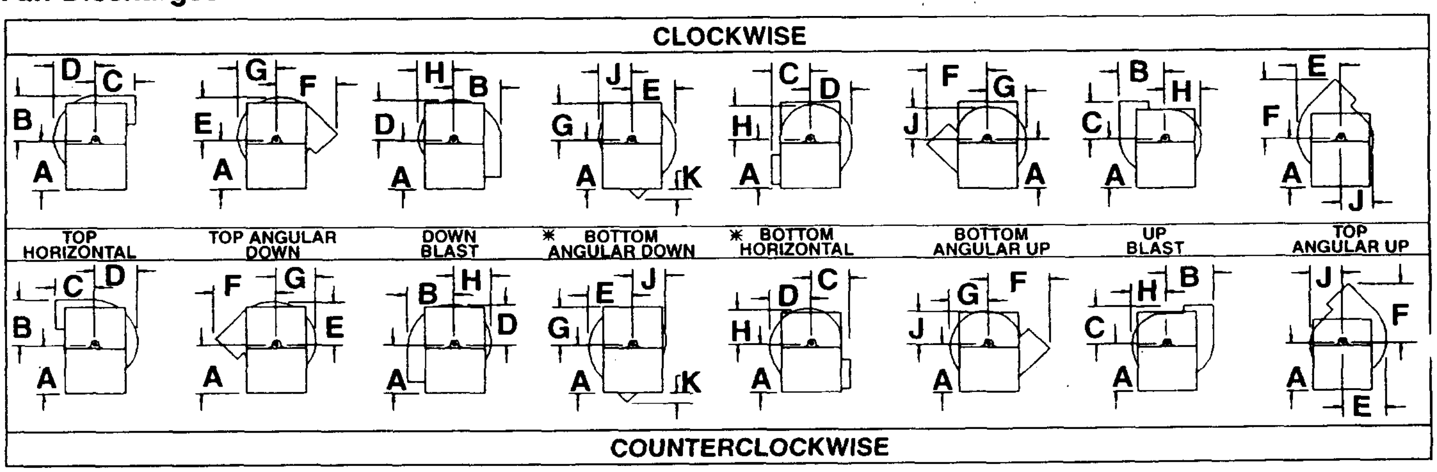
Principal Dimensions (Inches)

Fan Size	A	B	C	D	E	F	G	H	J	K	L	M	N
12	18 1/2	11 5/8	14 1/4	10 3/8	10 15/16	18 5/16	9 3/4	9 3/16	8 1/2	—	*18 3/4	5 1/2	1
15	21 1/2	14 3/4	16 5/8	13 3/16	13 15/16	22 3/16	12 3/8	11 11/16	10 13/16	11/16	*20 3/4	6 5/16	1
19	24 1/4	18 1/16	18 7/8	16 3/16	17 1/16	26 1/8	15 3/16	14 1/4	13 1/4	1 7/8	27 3/4	8 3/4	15/16
22	30	21 5/16	22	19 1/16	20 1/8	30 1/8	17 1/8	16 7/8	15 5/8	5/8	28 1/8	7 15/16	1
26	33 15/16	24 9/16	23 5/8	22	23 1/4	34 1/8	20 5/8	19 7/16	18 1/16	3/16	30	8 13/16	1
29	37	27 7/8	27 1/2	24 15/16	26 5/16	39 1/8	23 3/8	22	20 7/16	2 1/8	38 3/8	12 3/8	2 1/8

Fan Size	P	R	S	T	U	V	W	X	Y	Z	AA	BB	CC
12	8 1/8	7	7 1/8	16 1/4	18 1/4	11/16 x 1 1/16	*6	*24 3/4	12 3/4	—	*9 3/4	30 3/4	6 3/16
15	9 1/8	9	9	18 1/4	20 1/4	11/16 x 1 1/16	*6	*29 3/8	15 3/4	—	*11 3/8	35 7/8	7 13/16
19	12 11/16	11	11	25 3/8	27 1/4	11/16 x 1 1/16	8	35 11/16	18 3/4	9 3/8	14 11/16	42 11/16	9 9/16
22	12 11/16	13	12 15/16	25 3/8	27 3/8	11/16 x 1 1/16	8	37 1/4	20 1/4	10 1/8	14 3/4	45 3/4	11 1/4
26	12 11/16	15	14 7/8	25 3/8	27 3/8	11/16 x 1 1/16	8	41 3/16	22 1/2	11 1/4	16 7/16	50 11/16	12 15/16
29	16 7/8	17	16 5/8	33 3/4	38	11/16 x 1 1/16	9	47 3/8	22 3/4	11 3/8	21 1/8	55 3/8	14 7/16

Dimensions and specifications are subject to change. Certified prints are available.

Fan Discharges

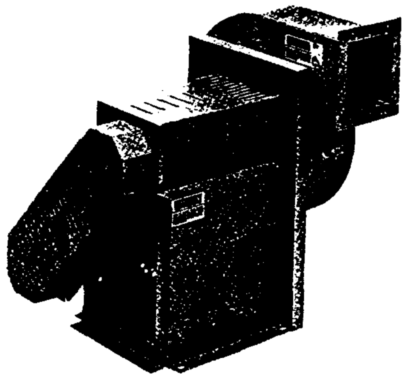


NOTE: For bottom angular down and/or down blast, contact factory when discharge flanges are required.

D-22

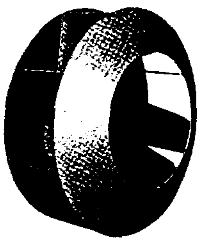
Industrial Exhauster (Belt Drive)

Hartzell Fan, Inc. certifies that all sizes and all wheel designations of the Series 052 Industrial Exhausters shown hereon, are licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Standard 211 and comply with the requirements of the Certified Ratings Program.



Series 052
Arrangement 9
(Shown with Accessories)

- **In stock models, Arrangements 9 and 10 less motor and drives, ship in 24 hours (see page 2).**
- **3-day shipment for in stock models with stock motor and drives mounted.**
- **5-day shipment for in stock models with counter-clockwise rotation, rotating of scroll, or mounted accessories including: guards, weather cover, drain kit, bolt-on access door, and high temp fan modification.**
- Designed to meet general industrial air-moving and pneumatic conveying requirements. Constructed of heavy gauge hot rolled steel.
- Drilled inlet and outlet flanges furnished as standard. Flanges 1½" wide.
- Air type AH wheel or open type MH wheel.
- Ceramic shaft seal is standard to minimize leakage.
- Stocked with shafts and bearings to accommodate maximum performance as shown. Full range of performance shown may not be available in Arrangements 9 and 10.
- Clockwise rotation. Top horizontal discharge. Rotatable in field. Downblast not available.
- High temperature fan – stock fans can be modified to high temp fans with heat slinger, high temp grease and motor heat shield. Max. temperature without weather cover is 600F°. With weather cover on arrangement 9, max. temp is 500F°, on arrangement 10, 250F°. Paint may be damaged by temperatures over 300F°.
- See page 27 for information about accessories available from stock.
- **For complete information on Certified Ratings Data, see Bulletin A-155.**



Air Wheel – Type AH

Backward inclined flat blades continuously welded to back plate and flat ring. Standard hub is straight bore with set screws. Ideal for handling air and gases at high pressure.

Rating Table – AH Wheel

Size	Max. BHP	Arr.9 & 10 Max. Mtr Frame	Fan RPM Range	CFM @ S.P. 4"	8"	12"	16"	Arr.1 Ship. Wgt.
12	10	184T	2208-4979	250-1800	350-1800	450-1800	500-1550	205
15	15	215T	1731-3893	400-3000	600-3000	700-3000	800-2500	336
19	20	256T	1386-3184	775-4400	1025-4400	1275-4400	1525-4150	478
22	30	256T	1220-2654	900-6150	1250-6150	1425-6150	1775-5625	655
26	40	286T	1056-2338	1250-8250	1750-8250	2000-8250	2250-7500	708
29	50	286T	886-2056	1500-10500	1500-10500	1800-10500	2100-10500	920

- **Performance shown is for Installation Type D: Ducted Inlet/Ducted Outlet.**
- **Power ratings (BHP) do not include drive losses.**
- **Performance ratings do not include the effects of appurtenances in the airstream.**

Open Wheel – Type MH

Non-clogging radial blades welded to heavy gauge back plate. Standard hub is straight bore with set screws. Sturdy wheel designed for resistance to the impact of dense or stringy material; tends to prevent material buildup.

Rating Table – MH Wheel

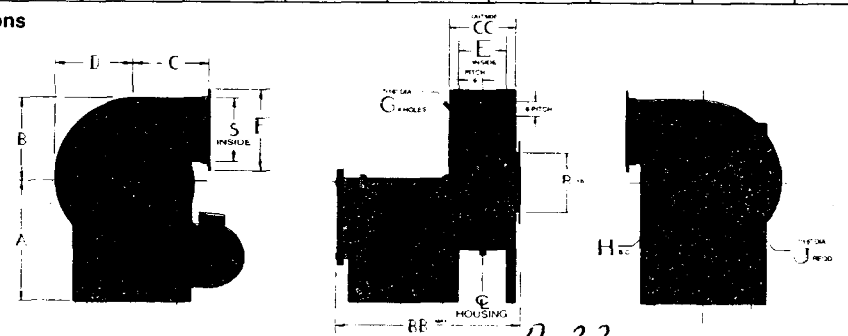
Size	Max. BHP	Arr.9 & 10 Max. Mtr Frame	Fan RPM Range	CFM @ S.P. 4"	8"	12"	16"	Arr.1 Ship. Wgt.
12	10	184T	2238-5054	250-1800	250-1800	300-1800	350-1500	200
15	15	215T	1754-3947	400-3000	400-3000	500-3000	600-2400	334
19	20	256T	1393-3177	650-4400	650-4400	900-4400	1025-4025	473
22	30	256T	1194-2688	900-6150	1250-6150	1425-6150	1600-5625	665
26	40	286T	1035-2328	1250-8250	1750-8250	2000-8250	2250-7500	708
29	50	286T	873-2059	1500-10500	1800-10500	2100-10500	2400-10500	920

- **Performance shown is for Installation Type D: Ducted Inlet/Ducted Outlet.**
- **Power ratings (BHP) do not include drive losses.**
- **Performance ratings do not include the effects of appurtenances in the airstream.**

Principal Dimensions (Inches)

Fan Size	A	B	C	D	E	F	G	H	J	R	S	BB	CC
12	18 1/2	11 5/8	14 1/4	10 3/8	5 13/16	10	8	8 3/4	6	7	6 3/4	30 3/4	9 3/32
15	21 1/2	14 1/4	16 5/8	13 3/16	7 13/32	11 7/8	8	10 3/4	6	9	8 19/32	35 7/8	10 11/16
19	24 1/4	18 1/16	18 7/8	16 3/16	9 3/32	13 7/8	10	12 3/4	6	11	10 1/2	42 11/16	12 7/16
22	30	21 5/16	22	19 1/16	10 3/4	15 13/16	10	14 3/4	6	13	12 7/16	45 3/4	14 1/8
26	33 15/16	24 9/16	23 5/8	22	12 13/32	17 3/4	12	16 3/4	6	15	14 3/8	50 11/16	15 3/4
29	37	27 7/8	27 1/2	24 15/16	14 3/32	19 11/16	12	18 3/4	8	17	16 5/16	55 3/8	17 7/16

Note: Dimensions and specifications are subject to change.
Certified prints are available.



Note: Inlet support are not standard for sizes 12 and 15 except when vibration isolators are specified.

Construction Features

Series 052

- **APPLICATION – the Hartzell Series 052, 053 and 054 industrial exhausters are designed to meet general industrial air moving and pneumatic conveying requirements. These high efficiency units are suited for material conveying, dust and fume removál and handling of hot air and industrial gases. Standard construction operates to 300°F (except Arrangement 4). Can be modified to work up to temperatures of 800°F. (See Pages 50 and 51).**
- **PERFORMANCE – Series 052 from 250 - 40,500 CFM, static pressure to 20″ water gauge. Series 053 from 1725 to 45,625 CFM, static pressure to 30″ water gauge. Series 054 from 2400 to 45,625 CFM, static pressure to 46″ water gauge.**
- **STANDARD CONSTRUCTION – Housing and bases built of heavy gauge hot rolled steel with continuous welds. Housing and base components are the same for all static pressure ranges. See material specification tables for wheel construction and drive sizes for Series 052, 053 and 054.**
- **EFFICIENCY – total efficiencies to 72%. Operates smoothly from free air to block off without excessive pulsation or vibration.**

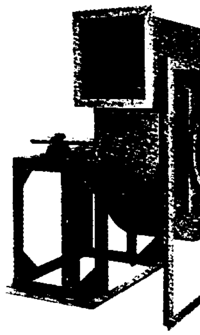
Features

- **Sizes** – twelve available sizes, 12″ through 57″ wheel diameters.
- **Arrangements** – available in Arrangement 1, 4, 8, 9, 9M, or 10.
- **Rotation** – clockwise and counterclockwise. Available discharges are shown on Pages 8 and 9. Sizes 12" through 29" housings are field rotatable. Sizes 33" through 57" housings are fixed.
- **Easy Installation and Maintenance** – motor, drive and bearings are readily accessible for ease in wiring installation, adjustment and lubrication. Access doors are available for clean-out.
- **Fan Assembly** – continuously welded hot-rolled steel scroll. Continuously welded steel angle for flanges when required. Bearings/motor pedestal and fan stand constructed of hot-rolled steel.
- **Wheel** – all wheels are dynamically and electronically balanced for smooth operation.
  Three non-clogging radial blades.
  - Type PW – 12" through 57"
  - Type MH – 12" through 57"
  - Type TH – 12" through 57"

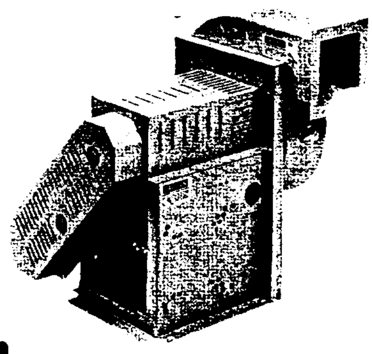
  An air wheel is also available for high pressure applications.
  - Type AH – 12″ through 57″

  Performance in this catalog is shown for fans with 100% width wheels. Partial wheels to 40% width are available for all designs. Contact factory.
- **Drive Assembly** – shafts are ground and polished, keyed at both ends. Shafts are designed to operate below 70% of the first critical speed. Bearings are heavy-duty, self-aligning, shielded and mechanically sealed in cast iron or malleable housing. Minimum L-10 life – 50,000 hours. Relubricable type for continuous service. Belts are oil-, heat- and static-resistant type, oversized for continuous duty. Variable pitch drives are standard on units up to and including 10 HP. Variable pitch drives can be furnished on higher horsepower units upon request.
- **Motors** – open end, drip proof are standard. Totally enclosed fan cooled and other special motors can be furnished upon request.
- **Surface Coatings** – standard coating is an industrial grade synthetic enamel. Alternate coatings are available for high-temperature and corrosive applications. (See Page 51.)
- **Accessories** – see Pages 50 and 51.
- **Optional Material Construction** – available in stainless steel construction with performance the same as hot-rolled steel units. Aluminum construction available. (Maximum operating temperature 350°F.)

D-24

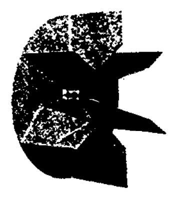


Arrangement 1



Arrangement 9

Wheel Design

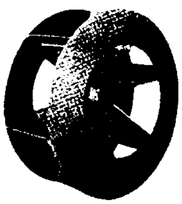


Open Wheel — Type MH

Non-clogging radial blades welded to heavy gauge back plate. Standard hub is straight bore with set screws. Split taper bushings available. Sturdy wheel designed for resistance to the impact of dense or stringy material; tends to prevent material buildup. Temperatures to 800°F. Maximum temperature for aluminum construction is 350°F.
- Series 052, sizes 12" through 57"
- Series 053, sizes 19" through 57"
- Series 054, sizes 22" through 57"

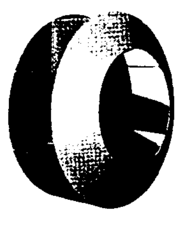
Open Paddle Wheel — Type PW

Rugged, non-clogging radial blades welded to the hub. Standard hub is straight bore with set screws. Split taper bushings available. Radial blades have continuously welded reinforcement to reduce stress. Designed for many air and material moving applications where abrasive particles, granular material, heavy dust or fumes are present in the air stre' Temperatures to 800°F. Maximum temperature aluminum construction is 350°F.
- Series 052, sizes 12" through 57"
- Series 053, sizes 19" through 57"
- Series 054, sizes 22" through 57"



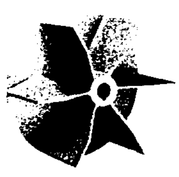
Reinforced Paddle Wheel — Type PWR

Closed back, flat ring, continuously welded radial blade wheels. Standard hub is straight bore with set screws. Split taper bushings available. Suited for handling particle-laden air, sawdust, granular material and gases. Temperatures to 800°F. Maximum temperature for aluminum construction — 350°F.
- Series 054, sizes 29" through 57"



Air Wheel — Type AH

Backward inclined flat blades continuously welded to back plate and flat ring. Standard hub is straight bore with set screws. Split taper bushings available. Ideal for handling air and gases at high pressure. Temperatures to 800°F. Maximum temperature for aluminum construction is 350°F.
- Series 052, sizes 12" through 57"
- Series 053, sizes 19" through 57"
- Series 054, sizes 22" through 57"



Open Wheel — Type TH

Designed specifically to convey paper trimmings, cardstock trimmings, and other similar materials. Wheel design includes features such as heavier blades, longer hub to withstand loads applir Modified inlet contributes to resistance to plugg from long materials. Available in all classes and sizes.
Note: For performance see MH Wheel
- Series 052, sizes 12" through 57"
- Series 053, sizes 19" through 57"
- Series 054, sizes 22" through 57"

EXISTING
AIR STRIPPER

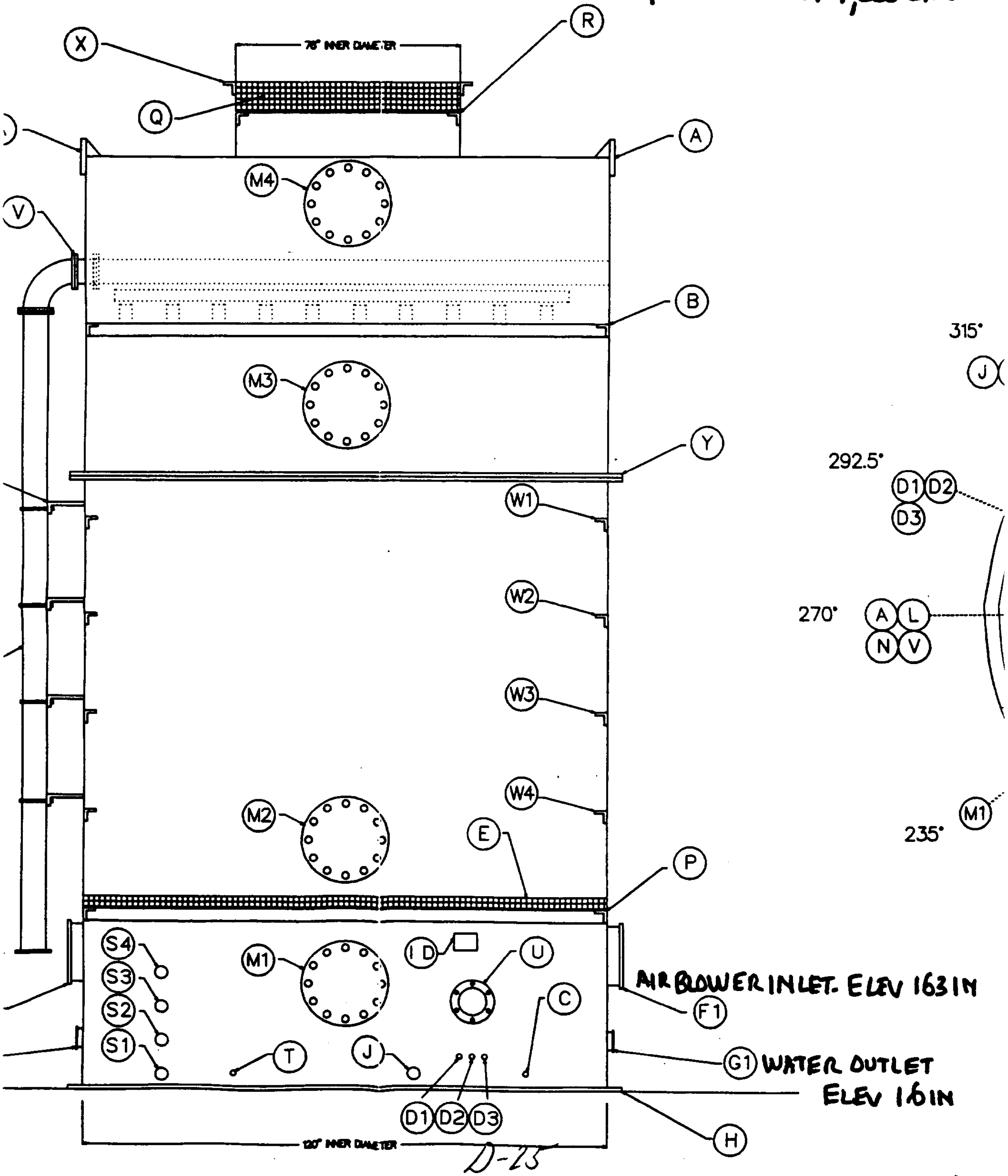
OVERALL HEIGHT OF TOWER AND STACK – 564"
PACKING SUPPORT GRATE HEIGHT – 168"
TOTAL HEIGHT OF PACKING – 300"

SUMP DEPTH = 163 - 16 = 147" = 12 FT

SUMP VOLUME:

$$\frac{(10^2 \times \pi)}{4} \times 12 = 936\ FT^3$$

or 7,000 GAL



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PRODUCT MANUALS
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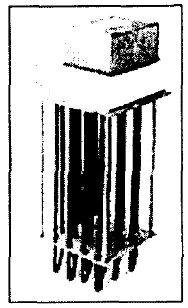
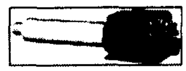
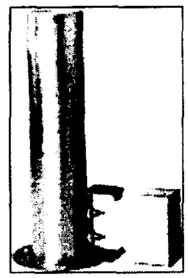
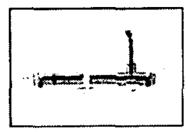
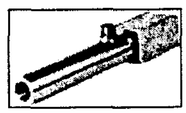
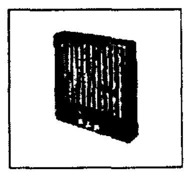
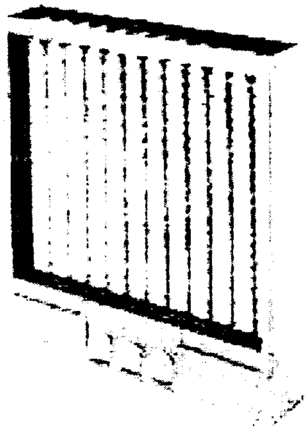
Process Air and Duct Heaters

Model	Description	Image
148000 Series	Handheld and Benchtop Heat Guns	
ADH and ADHT Series	HIGH TEMPERATURE AIR DUCT HEATERS	
AHC Series	Process Air Heater with Temperature Controls	
AHF Series	MAXIMUM FLOW AIR HEATERS, For Low Pressure, High Flow Air Heating	
AHP Series	"T"Type air Process Heaters For In-Line Air and Gas Heating	
AHPF Series	Low Flow Air Process and Liquid Circulation Heaters	
CAB and CABB Series	Low Temperature Air Duct Heaters	
DAB Series	Air Duct Heaters for Round Ductwork with Metal Enclosure	

D-26

LOW TEMPERATURE AIR DUCT HEATERS



CAB & CABB Styles

- Side Terminals (type CAB)
- Bottom Terminals (type CABB)
- 6 - 100 kW
- 120, 208, 240 and 480 Volt
- 1 or 3 Phase
- Rust-Resisting Iron or Chrome Steel Sheath Elements
- 440°F Max. Outlet Air Temp.

Applications

- Sole Heat Source
- Booster Heater in Process and Comfort Heating Ducts
- Convert existing Forced Air Dryers and Ovens
- With Blower and Duct, can be used to Fabricate simple Forced Air Drying Unit

Features

Simple Duct Transition Sections may be used to adapt standard heater sizes to various duct sizes to increase air velocities for better heat transfer, lower sheath temperature and longer element life.

Field Wiring Terminals — Heavy duty ⅜" diameter bolts of either brass (iron sheath units) or Stainless Steel (chrome steel sheath units) with necessary hardware are provided for field wiring connections. Terminals are located on the side for CAB units and on the bottom for CABB units, and should be on the outside of ducting.

Fins of aluminized steel are provided to improve heat transfer to the air.

Elements are individually replaceable.

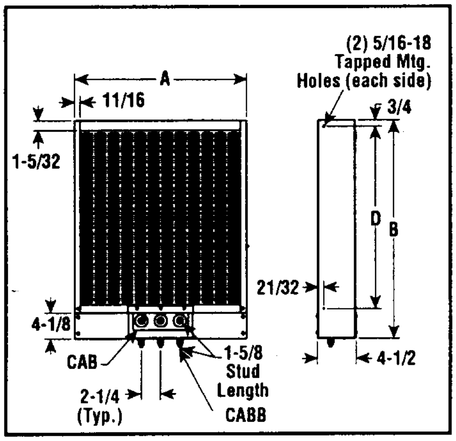
Terminal Cover Option is available to prevent accidental contact with live electrical terminals (PCN 269720), one (1) required per circuit, $89.

MONEL Sheath and MONEL Fins are available for humid conditions. Model TDH heaters, using Fintube elements are also available.

Construction

Rugged Finstrip Elements are mounted in a sturdy steel frame with narrow side of elements and fins facing the air flow.

Dimensions (Inches)



Finstrip Elements, Exclusive Construction — High-quality, coiled resistor wire is uniformly spaced over the width and length of the Finstrip element, then embedded in high-grade refractory material which insulates the wire and transfers heat rapidly. Refractory is then compressed to rock hardness and maximum density under tremendous hydraulic pressure to improve heat transfer from coil to sheath. Elements are oven baked at high temperatures to semi-vitrify and mature the refractory. Sheath material is either rust-resisting iron or chrome steel.

Sturdy Steel Frame — 14 gauge cold rolled steel painted with high heat resisting black enamel paint.

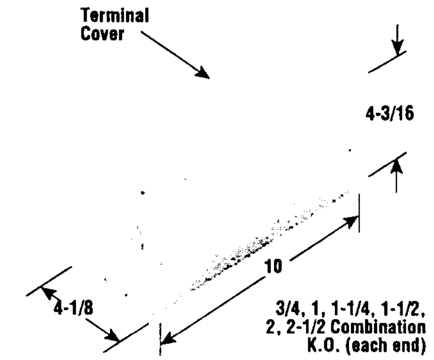
Internal Electrical Connections are made using a combination of buss bars and jumper straps consisting of either Manganese-Nickel or MONEL.

Mounting

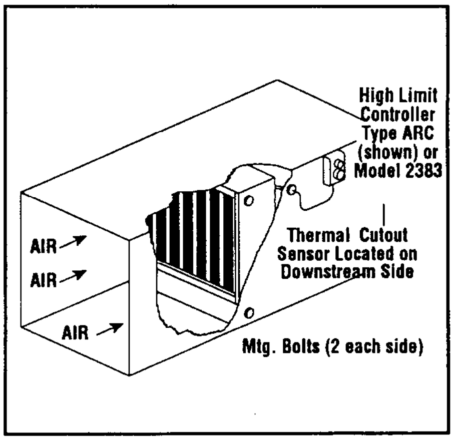
Always install heaters in duct work with terminal box on bottom of heater. Type CAB units should have field wiring terminals facing upstream to provide maximum cooling affect. Secure to duct work using mounting holes on both vertical sides of heater.

Application & Selection Guidelines

Selection Heater Size — Refer to Technical section for examples on determining kW requirements. For quick estimating purposes, the following formula may be used for air at standard conditions:



Overtemperature Protection

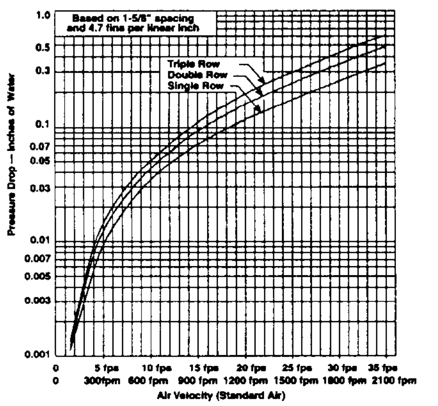


$$kW = \frac{SCFM \times Temp.\ Rise\ (°F)}{3000}$$

Maximum Work Temperatures — Type CAB and CABB heaters can generally be used at the following maximum temperatures, provided the minimum air velocity is maintained uniformly through the heater.

Air Velocity (Ft./Sec.)	Max. Outlet Air Temp. Iron Sheath	Chrome Steel Sheath
4	—	200
9	90	330
16	220	440

Note — Maximum temperatures are based on 26 W/In². If elements have a lower watt density, work temperatures may be increased; if watt density is higher, work temperatures should be lower.



LOW TEMPERATURE AIR DUCT HEATERS

CAB & CABB Styles

To Order *(Specify Model Number)*

MOST POPULAR MODELS HIGHLIGHTED!

kW	Volts	Phase	Amps/ Circ.	No. Circ.	No. Elem.	A	B	D	Rust-Resisting Iron Sheath Temperatures to 750°F Model No.	Price	Chrome Steel Sheath Temperatures to 950°F Model No.	Price	Wt. (Lbs.)
CAB — Side Terminals (26 W/In²)													
6	120	1	50	1	6	10¾	15⅞	11½	**CAB-62/120**	**$640**	**CAB-611/120**	**$715**	25
6	208	1	28.9	1	6	10¾	15⅞	11½	**CAB-62/208**	**640**	**CAB-611/208**	**715**	25
6	240	1	25	1	6	10¾	15⅞	11½	**CAB-62/240**	**640**	**CAB-611/240**	**715**	25
6	480	1	12.5	1	6	10¾	15⅞	11½	**CAB-62/480**	**640**	**CAB-611/480**	**715**	25
6	208	3	16.7	1	6	10¾	15⅞	11½	**CAB-62/208/3P**	**640**	**CAB-611/208/3P**	**715**	25
6	240	3	14.5	1	6	10¾	15⅞	11½	**CAB-62/240/3P**	**640**	**CAB-611/240/3P**	**715**	25
6	480	3	7.2	1	6	10¾	15⅞	11½	**CAB-62/480/3P**	**640**	**CAB-611/480/3P**	**715**	25
12	208	1	57.7	1	9	15⅜	18½	14⅛	**CAB-122/208**	**995**	**CAB-1211/208**	**1085**	35
12	240	1	50	1	9	15⅜	18½	14⅛	**CAB-122/240**	**995**	**CAB-1211/240**	**1085**	35
12	480	1	25	1	9	15⅜	18½	14⅛	**CAB-122/480**	**995**	**CAB-1211/480**	**1085**	35
12	208	3	33.4	1	9	15⅜	18½	14⅛	**CAB-122/208/3P**	**995**	**CAB-1211/208/3P**	**1085**	35
12	240	3	28.9	1	9	15⅜	18½	14⅛	**CAB-122/240/3P**	**995**	**CAB-1211/240/3P**	**1085**	35
12	480	3	14.5	1	9	15⅜	18½	14⅛	**CAB-122/480/3P**	**995**	**CAB-1211/480/3P**	**1085**	35
15	208	1	72.1	1	9	15⅜	21⅝	17¼	**CAB-152/208**	**1215**	**CAB-1511/208**	**1440**	40
15	240	1	62.5	1	9	15⅜	21⅝	17¼	**CAB-152/240**	**1215**	**CAB-1511/240**	**1440**	40
15	480	1	31.3	1	9	15⅜	21⅝	17¼	**CAB-152/480**	**1215**	**CAB-1511/480**	**1440**	40
15	208	3	41.7	1	9	15⅜	21⅝	17¼	**CAB-152/208/3P**	**1215**	**CAB-1511/208/3P**	**1440**	40
15	240	3	36.1	1	9	15⅜	21⅝	17¼	**CAB-152/240/3P**	**1215**	**CAB-1511/240/3P**	**1440**	40
15	480	3	18.1	1	9	15⅜	21⅝	17¼	**CAB-152/480/3P**	**1215**	**CAB-1511/480/3P**	**1440**	40
20	208	3	55.6	1	12	20⅛	21⅝	17¼	**CAB-202/208**	**1535**	**CAB-2011/208**	**1810**	55
20	240	3	48.2	1	12	20⅛	21⅝	17¼	**CAB-202/240**	**1535**	**CAB-2011/240**	**1810**	55
20	480	3	24.1	1	12	20⅛	21⅝	17¼	**CAB-202/480**	**1535**	**CAB-2011/480**	**1810**	55
25	208	3	69.5	1	12	20⅛	26⅛	21¾	**CAB-252/208**	**1790**	**CAB-2511/208**	**2175**	65
25	240	3	60.2	1	12	20⅛	26⅛	21¾	**CAB-252/240**	**1790**	**CAB-2511/240**	**2175**	65
25	480	3	30.1	1	12	20⅛	26⅛	21¾	**CAB-252/480**	**1790**	**CAB-2511/480**	**2175**	65
30	480	3	18.1	2	18	29½	21⅝	17¼	—	—	**CAB-3011/480**	**2215**	75
40	208	3	55.6	2	18	29½	27⅜	23	**CAB-402/208**	**2290**	**CAB-4011/208**	**2680**	90
40	240	3	48.2	2	18	29½	27⅜	23	**CAB-402/240**	**2290**	**CAB-4011/240**	**2680**	90
40	480	3	24.1	2	18	29½	27⅜	23	**CAB-402/480**	**2290**	**CAB-4011/480**	**2680**	90
50	208	3	69.5	2	18	29½	33⅛	28¾	**CAB-502/208**	**2940**	**CAB-5011/208**	**3395**	110
50	240	3	60.2	2	18	29½	33⅛	28¾	**CAB-502/240**	**2940**	**CAB-5011/240**	**3395**	110
50	480	3	30.1	2	18	29½	33⅛	28¾	**CAB-502/480**	**2940**	**CAB-5011/480**	**3395**	110
75	208	3	69.5	3	27	44 7/16	42⅛	37¾	**CAB-752/208**	**4395**	**CAB-7511/208**	**4745**	200
75	240	3	60.2	3	27	44 7/16	42⅛	37¾	**CAB-752/240**	**4395**	**CAB-7511/240**	**4745**	200
75	480	3	30.1	3	27	44 7/16	42⅛	37¾	**CAB-752/480**	**4395**	**CAB-7511/480**	**4745**	200
100	208	3	92.6	3	27	44 7/16	47½	43⅛	**CAB-1002/208**	**5640**	**CAB-10021/208**	**5900**	220
100	240	3	80.3	3	27	44 7/16	47½	43⅛	**CAB-1002/208**	**5640**	**CAB-10021/208**	**5900**	220
100	480	3	40.1	3	27	44 7/16	47½	43⅛	**CAB-1002/480**	**5640**	**CAB-10021/480**	**5900**	220
CABB — Bottom Terminals (26 W/In²)													
6	240	3	14.5	1	6	10¾	15⅞	11½	—	—	**CABB-611/240**	**795**	25
6	480	3	7.2	1	6	10¾	15⅞	11½	—	—	**CABB-611/480**	**795**	25
12	208	3	33.4	1	9	15⅜	18½	14⅛	—	—	**CABB-1211/208**	**1170**	35
12	240	3	28.9	1	9	15⅜	18½	14⅛	—	—	**CABB-1211/240**	**1170**	35
12	480	3	14.5	1	9	15⅜	18½	14⅛	—	—	**CABB-1211/480**	**1170**	35
20	480	3	24.1	1	12	20⅛	21⅝	17¼	—	—	**CABB-2011/480**	**1889**	55
25	480	3	30.1	1	12	29½	26⅛	21¾	**CABB-252/480**	**1875**	**CABB-2511/480**	**2251**	65
40	480	3	24.1	2	18	29½	27⅜	23	**CABB-402/480**	**2370**	**CABB-4011/480**	**2762**	90
50	480	3	30.1	2	18	29½	33⅛	28¾	**CABB-502/480**	**3020**	**CABB-5011/480**	**3473**	110
75	480	3	30.1	3	27	44 7/16	42⅛	37¾	**CABB-752/480**	**4475**	**CABB-7511/480**	**4826**	200
100	480	3	40.1	3	27	44 7/16	47½	43⅛	**CABB-1002/480**	**5715**	**CABB-10021/480**	**5989**	220

Ordering Example: CAB-252/480** is a rust-resisting iron sheath heater, 25 kW, 480 Volt, **$1790.

Free Area for Air Flow

Model No	Square Feet	Model No.	Square Feet
CAB-62 & 611	0.500	**CAB-402 & 4011**	3.29
CAB-122 & 1211	0.927	**CAB-502 & 5011**	4.13
CAB-152 & 1511	1.19	**CAB-752 & 7511**	8.25
CAB-202 & 2011	1.63	**CAB-1002 & 10021**	9.38
CAB-252 & 2511	2.07		

Note — The volume of air being circulated along with the free area for air flow (in table above) will enable you to calculate the air velocity over the heater.

J

Gas Phase
Carbon Adsorbers

Carbonair's gas phase carbon adsorbers are designed to provide an efficient and economical means to control odor, toxic vapors and corrosive gases. Several types of activated carbons are available for a variety of applications.

DESIGN

GPC 3 & 3H
- UN Standard 55-gallon steel drum.
- Two 2" PVC connections. (GPC 3)
- Two 4" PVC connections. (GPC 3H)
- Baked enamel exterior.
- Epoxy-phenolic interior lining.
- Quick installation.

Carbon Cap.: GPC 3 - 200 lbs.
GPC 3H - 200 lbs.

GPC 3.85
- UN Standard 85-gallon steel drum.
- Two 4" PVC connections.
- Baked enamel exterior.
- Epoxy-phenolic interior lining.
- PVC internals.

Carbon Cap.: GPC 3.85 - 250 lbs.

GPC 5R
- Welded steel round construction.
- Two 4" NPT connections.
- One ½" drain.
- Fork tubes for easy lifting.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- FRP grate with stainless steel screen.

Carbon Cap.: GPC 5R - 500 lbs.

GPC 7R
- Welded steel round construction.
- Two 6 ⅝" nozzle connections.
- FRP grate with stainless steel screen.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- Fork tubes for easy lifting.

Carbon Cap.: GPC 7R - 1000 lbs.

GPC 13R & GPC 20R
- Welded steel round construction.
- Fork tubes for easy lifting.
- One condensation drain.
- FRP grate with stainless steel screen.
- Polyamide epoxy/urethane interior & exterior finish.
- Two 8 ⅝" nozzle connections.

Carbon Cap.: GPC 13R - 1,500 lbs.
GPC 20R - 2,000 lbs.

GPC 50R
- Welded steel round construction.
- Fork tubes for easy lifting.
- FRP grate with stainless steel screen.
- Two 12 ¾" nozzle connections.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- Two ½" drain/sample couplings.

Carbon Cap.: GPC 50R - 5,000 lbs.

GPC 70 & 120
- Welded steel rectangular construction.
- Skid mounted with lifting lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- FRP grate with stainless steel screen.
- Four 12¾" inlet ports.
- Two quick-disconnect off-gas ports.
- Two sample ports.
- One condensation drain.

Carbon Cap.: GPC 70 - 10,000 lbs.
GPC 120 - 13,600 lbs.

OPTIONS

Blowers Humidity control
Influent/effluent ducting
Discharge stack Controls
Additional sampling couplings and valves

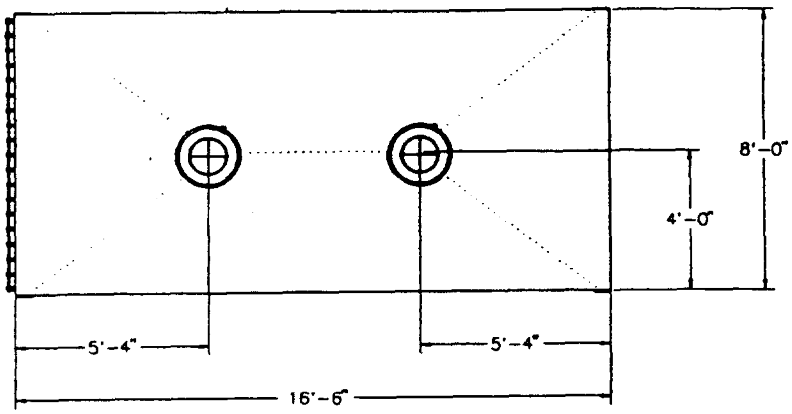
CARBONAIR
ENVIRONMENTAL SERVICES
2731 Nevada Avenue North
New Hope, MN 55427
612-544-2154 800-526-4999
Fax 612-544-2151

D-30

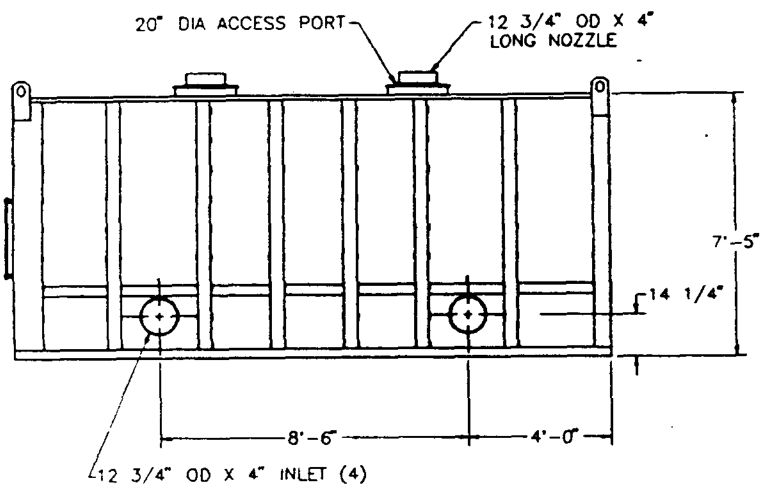
SPECIFICATIONS

MODELS	GPC 3	GPC 3H	GPC 3.85	GPC 5R	GPC 7R	GPC 13R	GPC 20R	GPC 50R	GPC 70	GPC 120
DIMENSIONS	24½" OD (0.62 m) 36½"H (0.93 m)	24½" OD (0.62 m) 36½"H (0.93 m)	28½" OD (0.72 m) 38½"H (0.98 m)	30" OD (0.76 m) 5'8"H (1.73 m)	3' OD (0.91 m) 7'2"H (2.18 m)	4' OD (1.2 m) 7'2"H (2.18 m)	5' OD (1.5 m) 7'2"H (2.18 m)	8' OD (2.44 m) 7'2"H (2.18 m)	16'8½"L x 5'W x 7'6" H (5.0 m x 1.5 m x 2.3 m)	16'6"L x 8'W x 7'10"H (5.0 m x 2.4 m x 2.4 m)
BED AREA	2.7 sq.ft. (0.29 sq.m)	2.7 sq.ft. (0.29 sq.m)	3.68 sq.ft. (0.39 sq.m)	4.91 sq.ft. (0.53 sq.m)	7.07 sq.ft. (0.76 sq.m)	12.57 sq.ft. (1.35 sq.m)	19.63 sq.ft. (2.11 sq.m)	50.27 sq.ft. (5.41 sq.m)	69.8 sq.ft. (6.49 sq.m)	120 sq.ft. (11.15 sq.m)
FLOW RANGE	20-100 cfm (0.6-3 m^3/min)	20-270 cfm (0.6-8 m^3/min)	36-360 cfm (1-10 m^3/min)	40-380 cfm (1-10 m^3/min)	76-500 cfm (2-15 m^3/min)	120-800 cfm (3-24 m^3/min)	200-1,800 cfm (6-54 m^3/min)	480-4,000 cfm (14-120 m^3/min)	700-7,000 cfm (20-200 m^3/min)	200-12,000 cfm (34-340 m^3/min)
CARBON CAPACITY	200 lbs (68 kg)	200 lbs (68 kg)	250 lbs (114 kg)	500 lbs (228 kg)	1,000 lbs (456 kg)	1,500 lbs (681 kg)	2,000 lbs (908 kg)	5,000 lbs (2,270 kg)	10,000 lbs (4,540 kg)	13,600 lbs (6,174 kg)
FITTINGS	1½" PVC inlet and outlet ports	4" PVC inlet and outlet ports	4" PVC inlet and outlet ports	4½" nozzle (2) ½" half couplings (1) 30" access port	6 ⅝" nozzle (2) ½" half couplings (1) 24" access port	8 ⅝" nozzle (2) ½" half couplings (1) 24" access port	8 ⅝" nozzle (2) ½" half couplings (1) 24" access port	12 ¾" nozzle (2) ½" half couplings (1) 24" access port	(4) 12¾" inlet nozzles (2) 12¾" outlet nozzles 1" condensate drain (2) ¾" half coupling (2) 20" access ports	(4) 12¾" inlet nozzles (2) 12¾" outlet nozzles 1" condensate drain (2) ¾" half coupling (2) 20" access ports
EMPTY WEIGHT	65 lbs (29 kg)	65 lbs (29 kg)	100 lbs (45 kg)	375 lbs (170 kg)	700 lbs (317 kg)	950 lbs (431 kg)	1,200 lbs (544 kg)	2,900 lbs (1,315 kg)	5,500 lbs (2,495 kg)	7,500 lbs (3,402 kg)
OPERATING WEIGHT	275 lbs (125 kg)	275 lbs (125 kg)	350 lbs (159 kg)	900 lbs (408 kg)	1,800 lbs (816 kg)	2,450 lbs (1,111 kg)	3,200 lbs (1,452 kg)	8,000 lbs (3,629 kg)	16,000 lbs (7,258 kg)	22,000 lbs (9,979 kg)
INLET/OUTLET NOZZLES	1½" (3.81 cm)	4" (10.16 cm)	4" (10.16 cm)	4½" (11.43 cm)	6 ⅝" (16.83 cm)	8 ⅝" (21.9 cm)	8 ⅝" (21.9cm)	12 ¾" (32.38 cm)	12 ¾" (32.38 cm)	12 ¾" (32.38 cm)

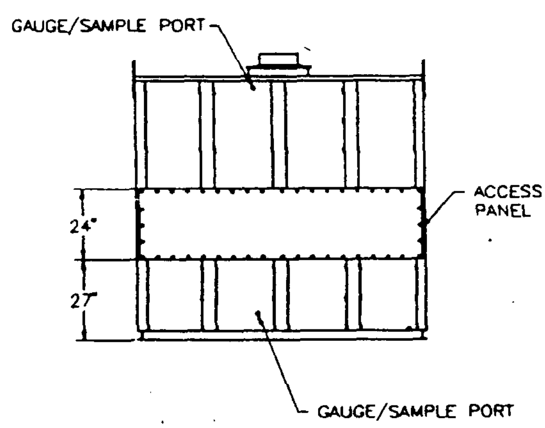
Carbon Adsorber–Vapor Phase
GPC 120



TOP VIEW



SIDE VIEW



END VIEW

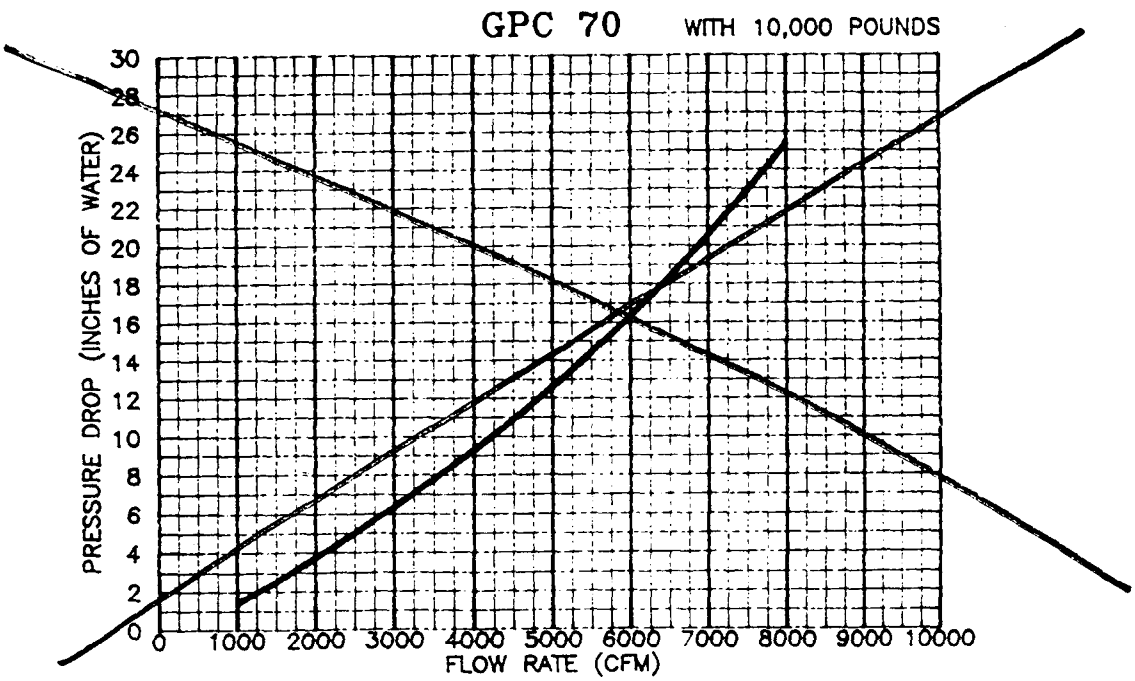
VESSEL CAPACITY IS 13,600 LBS.
OF CARBON.

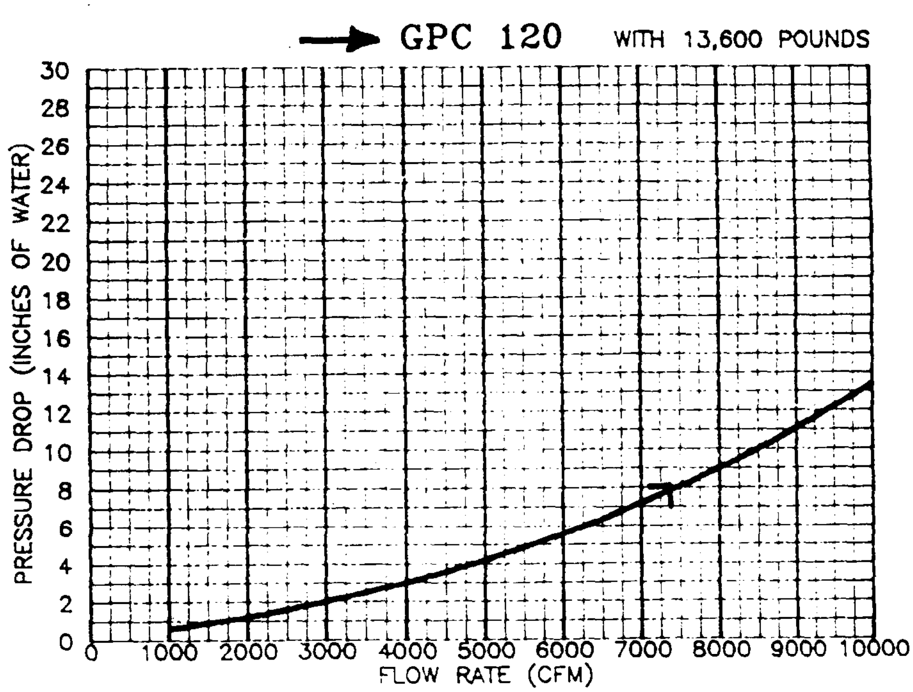
Sales Drawing #116438
11.11.96

D-31

PRESSURE DROP THROUGH CARBONAIR VAPOR-PHASE CARBON UNITS

Based on: CECA 410 GE Carbon
Temperature: 70°F





Sales Drawing #117226(04)
93.11.16

Equipment Bulletin

MODEL 10 MODULAR CARBON ADSORPTION SYSTEM

Description

The Calgon Carbon Model 10 is an adsorption system designed for the removal of dissolved organic contaminants from liquids using granular activated carbon. The modular design concept allows selection of options or alternate materials to best meet the requirements of the site and treatment application.

The Model 10 system is delivered as two adsorbers and a compact center piping network, requiring only minimal field assembly and site connections. An optional mounting skid is available to facilitate installation. The pre-engineered Model 10 design assures that all adsorption system functions can be performed with the provided equipment.

The process piping network for the Model 10 accommodates operation of the adsorbers in parallel or series (with either adsorber placed in first stage). The piping can also isolate either adsorber from the flow. This permits carbon exchange or backwash operations to be performed on one adsorber without interrupting treatment.

The unique internal cone under-drain design provides for the efficient collection of treated water and the distribution of backwash water. The internal cone also insures efficient and complete discharge of spent carbon from the adsorber. The Model 10 system is designed for use with Calgon Carbon's closed loop carbon exchange service. Using special designed trailers, spent carbon is removed from the adsorbers and returned to Calgon Carbon for reactivation. The trailers also recharge the adsorbers with fresh activated carbon.

System Specifications

Carbon Adsorbers

- Carbon steel ASME code pressure vessels
- Internal vinyl ester lining (nominal 35 mil) where GAC contacts steel, for potable water and most liquid applications
- Polypropylene slotted nozzles for water collection and backwash distribution

Standard Adsorption System Piping

- Schedule 40 carbon steel process piping with cast iron fittings
- Full bore stainless stell ball valves for GAC fill and discharge
- PPL lined steel pipe for GAC discharge
- Cast iron buterfly valves for process piping

System External Coating

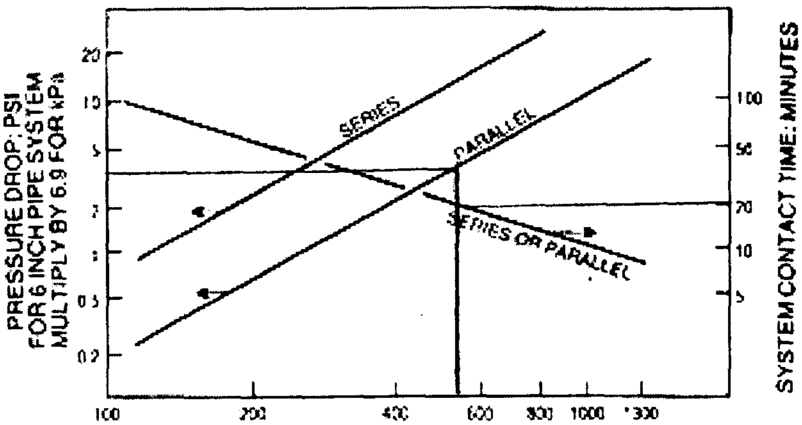
- Epoxy mastic paint system

Available Options

- Unifying system skid
- In-bed water sample collection probes

Operating Conditions

Carbon per Adsorber	20,000 lbs. (9080 kg)
Pressure Rating	125 psig (862 kPa)
Pressure Relief	Graphite rupture disk (94 psig)
Vacuum Rating	14 psig
Temperature Rating	150^{o}F maximum (65^{o}C)
Backwash Rate	Typical 1000 gpm (30% expansion)
Carbon Transfer	Air pressure slurry transfer
Utility Air	100 scfm at 30 psig (reduce to 15 psig for trailer)
Utility Water	100 gpm at 30 psig
Freeze Protection	None provided; enclosure or protection recommended



Dimensions and Field Conditions

Adsorber Vessel Diameter	10 ft. (3050 mm)
Process Pipe	6 in. or 8 in.
Process Pipe Connection	125# ANSI flange
Utility Water Connection	3/4 in. hose connection
Utility air Connection	3/4 in. hose connection
Carbon Hose Connection	4 in. Kamlock type
Carbon Dry Fill	Top 8" nozzle
Backwash Connections	6 in. or 8 in. flange
Drain/vent Connection	6 in. or 8 in. flange
Adsorber Maintenance Access	20 in. round flanged man-way, 14 in. x 18 in. man-way below cone
Adsorber Shipping Weight	18,500 lbs. (empty) (8400 kg)
System Operating Weight	215,000 lbs. (97,610 kg)

Caution

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low-oxygen spaces should be followed, including all applicable federal and state requirements.

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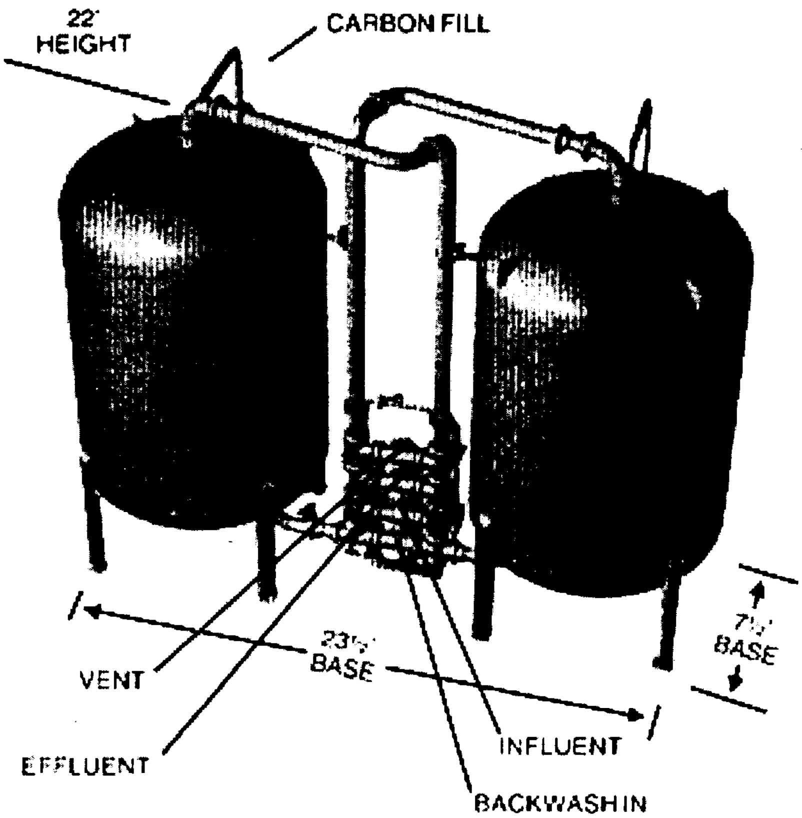

Safety Message

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Equipment Bulletin

Model 12 Modular Carbon Adsorption System

Description

The Calgon Carbon Model 12 Adsorption System is designed to provide cost-effective removal of organic contaminants from contaminated water sources by using granular activated carbon. The system incorporates a low profile design that allows easy blending with natural surroundings.

The Model 12 system is particularly suitable for well water systems, as the units are rated for system pressures which allow treatment without re-pumping. A single unit can accommodate flows up to 700 gallons per minute per vessel and is especially effective for applications with low levels of organic chemical contaminants. The system can be backwashed to remove suspended solids which may collect on the carbon bed.

The Model 12 is a complete water treatment system, with pre-fabricated piping for ease of installation. The piping is centrally located to allow enclosure, if additional architectural aesthetics are required.

The water piping is designed to allow for parallel flow or single stage operation, but a simple piping adjustment can allow the two vessels to be operated in series. In addition, all other piping is designed to allow for effective operation. This includes backwash supply and discharge, carbon transfer and venting operations, safety relief, utility water and compressed air. All piping sections are pre-fabricated for ease of installation at the site.

The Model 12 adsorber vessels are ASME stamped and coded for 125 psig pressure rated service, lined for corrosion resistance, and designed to contain 20,000 lbs of Calgon Carbon's granular activated carbon. The under-drain design maximizes the utility of carbon in the vessel, and minimizes maintenance. Carbon transfer piping allows use of the Calgon Carbon Service℠ which offers the use of special transfer trailers and closed loop transfers for quick, clean media exchange.

Your Calgon Carbon Technical Sales Representative can help you evaluate the suitability of the Model 12 to satisfy your water treatment requirements. When needed, adsorption evaluation tests or studies to determine applicability and economics can be arranged. Calgon Carbon also offers adsorption equipment in many other sizes, and carbon supply and exchange services to meet your particular requirements.

Features

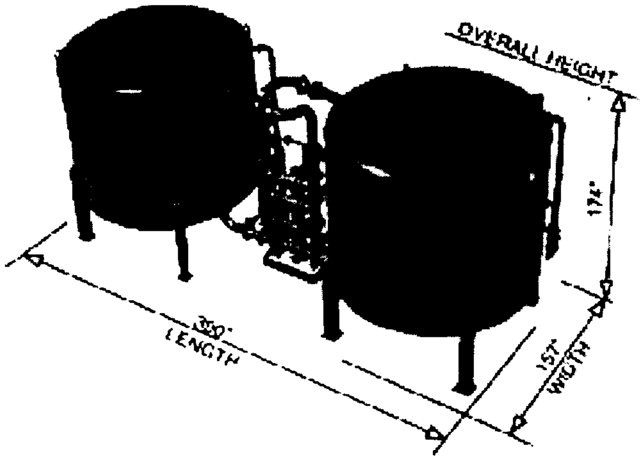
- Proven design - down-flow fixed bed adsorption
- Four point inlet distribution and backwash collection is available
- In-bed sample taps are available
- ASME coded vessels with vinyl ester resin lining approved for potable water use
- 20 inch man-way for maintenance access. Other sizes are available
- Multiple under-drain configurations available to optimize carbon usage and minimize maintenance
- Backwash capability to maintain pressure drop characteristics
- All piping and valves meet AWWA specifications
- Granular activated carbon fill and discharge piping to provide closed loop exchange services
- Pre-engineered
- Overall system height less than 15 ft. with side entry piping. Top entry piping also available.

Operation Modes

- Down-flow fixed bed
- Parallel flow, with adsorbers isolated for backwash or carbon exchange
- Series operation

Specifications

Vessel Diameter 12 ft.
ASME Code 125 PSIG @ 150oF
Water Pipe Connections 8" flange connection
Carbon Volume per Vessel 715 cu.ft. (nominal 20,000 lbs granular activated carbon)
Weight Empty - 48,000 lbs
Operating - 265,000 lbs
Pressure Relief 94 PSIG nominal setting (112 PSIG optional setting)
Backwash Rate 1200 GPM
Transfer Mode Air pressurized slurry transfer
Empty Bed Contact Time 7 1/2 minutes per bed at 700 gpm



Model 12 adsorption system

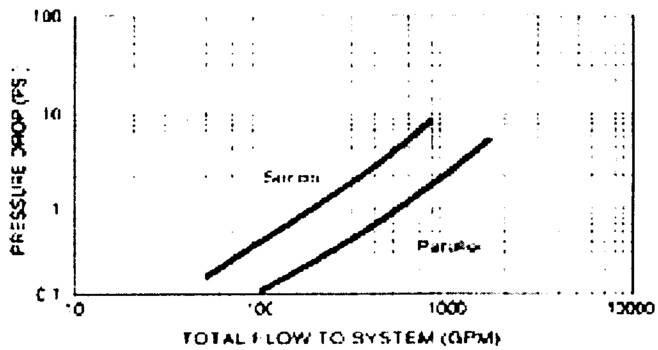
Materials of Constructions

Vessel Lining - Vinyl Ester suitable for potable water.

Piping and Valves - Carbon steel piping, cast iron fittings and cast iron butterfly (water) and stainless steel ball valves (carbon transfer). Other materials of construction are available.

Under-drain Collection System - Multiple configurations available with various combinations of stainless and polypropylene materials of construction.

External Coating - Epoxy Mastic Coating.



Model 12 Pressure Drop
Filtrasorb 300 Carbon (55°F)
8" Sch. 40 Carbon Steel Pipe

Caution

Wet activated carbon preferentially removes oxygen from the air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable federal and state requirements.

Calgon Carbon Corporation reserves the right to change specifications without notice for components of equal quality.

Safety Message

Wet activated carbon preferentially removes oxygen from air. In closed or partially closed containers and vessels, oxygen depletion may reach hazardous levels. If workers are to enter a vessel containing carbon, appropriate sampling and work procedures for potentially low oxygen spaces should be followed, including all applicable federal and state requirements.

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